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ABSTRACT

This subcourse containg lesson assignments, lesson texts, and programmed reviews covers the most frequently used equipment for transporting and storing petroleum products from the time they are purchased until they are consumed by the user. The course is one of a number of military-developed curriculum packages selected for adaptation to vocational instruction and curriculum development in a civilian setting. Three lessons are included in the course. Lesson 1, Petroleum Equipment and Operations, covers bulk petroleum transporters and refuelers, gaging equipment, and use of the fuel system supply point. Lesson 2, Quality Surveillance and Petroleum Testing Facilities, includes categories of petroleum products; use of military and federal specifications; importance of and responsibility for the POL quality surveillance program; indications, causes, and disposition of off-specification products; and army petroleum laboratories and equipment. Lesson 3, Military Petroleum Pipelines, covers components of a military pipeline, advantages and disadvantages of pipelines; and identification of pipelines operated by the Army in World War II and currently. Each lesson in the course is designed for self-evaluation. This is done through the self-grading exercises which must be worked after studying each lesson text. An examination booklet is included. (LRA)

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This military technical training course has been selected and adapted by The Center for Vocational Education for "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education," a project sponsored by the Bureau of Occupational and Adult Education, U.S. Department of Health, Education, and Welfare.

PETROLEUM EQUIPMENT AND TECHNICAL OPERATIONS
QM0142

Correspondence Course 19-5

Developed by:
United States Army

Development and Review Dates:
1978

Occupational Area:
Warehousing, Packing and Distribution

Print Pages:
94

Availability:
Vocational Curriculum Coordination Centers

Suggested Background:

None

Target Audiences:

Grades 11 - Adult

Organization of Materials:

A subcourse booklet containing lesson assignments, lesson texts and programmed reviews.

Type of Instruction:

Individualized, self-paced

Type of Materials:	No. of Pages:	Average Completion Time:
Lesson 1 - Petroleum Equipment and Operations	30	1 hour
Lesson 2 - Quality Surveillance and Petroleum Testing Facilities	24	2 hours
Lesson 3 - Military Petroleum Pipelines	14	1 hour
Examination	13	1 hour

Supplementary Materials Required:

None

Course Description:

Petroleum Equipment and Technical Operations covers the most frequently used equipment for transporting and storing petroleum products from the time they are purchased until they are consumed by the user. This subcourse briefly discusses procurement inspection and discusses the importance of quality surveillance programs and how such programs are conducted. In addition, it describes, gives the purpose of, and illustrates equipment used in handling petroleum products, such as containers, pumps, tank cars, tank vehicles, and pipelines. This course contains 3 lessons covering the following topics:

Lesson 1 - Petroleum Equipment and Operations covers bulk petroleum transporters and refuelers; gaging equipment, and use of the fuel system supply point.

Lesson 2 - Quality Surveillance and Petroleum Testing Facilities includes categories of petroleum products; use of military and Federal specifications; importance of and responsibility for the POL quality surveillance program; indications, causes, and disposition of off-specification products; and Army petroleum laboratories and equipment.

Lesson 3 - Military Petroleum Pipelines covers components of a military pipeline; advantages and disadvantages of pipelines; and identification of pipelines operated by the US Army in World War II and currently.

Each lesson in this subcourse is designed for self-evaluation. This is done through the self-grading exercises which must be worked after studying each lesson text. An examination booklet is included within the subcourse booklet. However, the solution to this examination is not available.

PETROLEUM EQUIPMENT AND TECHNICAL OPERATIONS COORESPONDENCE COURSE
QM0142

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MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

SCHOOL CODE
101
SUBCOURSE ED
QMO142 8

U.S. Army Training Support Center

Fort Eustis, Virginia

PETROLEUM EQUIPMENT AND TECHNICAL OPERATIONS

ARMY CORRESPONDENCE COURSE PROGRAM

NOTICE

"This subcourse has been reprinted as a single volume by the US Army Training Support Center. It includes all materials necessary to work this subcourse, with the exception of minor items of supply, such as pencils, compasses, pins, triangles, and similar items. You are required to provide these yourself. Your return address envelope for mailing your answer card or answer sheet is bound in as the last page."

QM0142

PETROLEUM EQUIPMENT AND TECHNICAL OPERATIONS

SECTION I

INTRODUCTION

1. SCOPE. Petroleum Equipment and Technical Operations covers the most frequently used equipment for transporting and storing petroleum products from the time they are purchased by the military until they are consumed by the user. The subcourse briefly discusses procurement inspection and discusses the importance of quality surveillance programs and how such programs are conducted. In addition, it describes, gives the purpose of, and illustrates equipment used in handling petroleum products, such as containers, pumps, tank cars, tank vehicles, and pipelines.

2. APPLICABILITY. This subcourse is of interest to all Army personnel who are involved in, or anticipate involvement in, handling petroleum products. Successfully completed, this subcourse will provide the student with a working knowledge of petroleum equipment and technical procedures. This knowledge, reinforced by experience or further training, will enable the student to perform effectively in an assignment involving petroleum equipment or technical procedures.

3. PROGRAM OF CONTINUING STUDY. When you successfully complete this subcourse, we recommend that you apply to take one or more of the following:

a. QM0470, Military Petroleum Products and Containers.

b. QM0557, Petroleum Procurement, Distribution, and Disposal

SECTION II

ADMINISTRATIVE INSTRUCTIONS

4. RECEIPT OF MATERIALS.

a. Check your subcourse materials. Each subcourse packet that you receive will consist of one or more of the following: a subcourse booklet, reference text(s), lesson solution(s), an examination, an examination response sheet, and a self-addressed, franked envelope for returning your examination response sheet. To determine the reference materials needed to complete your subcourse requirement, read the introduction in the subcourse booklet. It lists the number of lessons, reference text(s), and other items which are issued with the subcourse packet. Please notify us immediately of any shortages.

b. Do not return any course materials. Do not return any of the items, i.e., subcourse booklet, Field Manual, Army Regulation, Special Text, commercial text, etc., sent to you.

5. SUBCOURSE ORGANIZATION. This subcourse is organized into this single booklet containing materials needed to complete the subcourse. If additional materials are needed, they are indicated on the booklet cover. This subcourse booklet consists of lessons and an examination. Each lesson consists of a lesson assignment, contents pages, lesson text, and self-grading lesson exercises.

6. LESSON TESTS. Each lesson in this subcourse is designed for self-evaluation. This is done through the self-grading exercises which you must work after studying each lesson text. You will find instructions for completing the exercises in each lesson. Because you complete the lesson tests and verify your own work, you do not submit your answers for grading. This is what is meant by the self-evaluation characteristic of this subcourse's lessons. You will receive credit for the total hours of this subcourse upon successful completion of the examination.

7. TESTS AND EXAMINATIONS. Each subcourse has an examination booklet bound together with the subcourse booklet. ONLY THE EXAMINATION RESPONSE SHEET IS SUBMITTED FOR GRADING. To indicate your examination responses, circle your answer to each question in the examination booklet and retain this until you have received your results.

8. PREPARING YOUR EXAMINATION RESPONSE SHEET.

a. Description of the response sheet. The US Army Training Support Center uses a standard examination response sheet. This sheet has mark-sense blocks and can only be used for multiple choice testing.

b. CHECK YOUR RESPONSE SHEET: Make sure you have the correct examination response sheet. Verify your social security number (SSN), the subcourse number, edition number, and examination version number. These should be the same on both the study materials and the examination response sheet. If any of these numbers are incorrect, call your counselor for issuance of a corrected response sheet, or return the response sheet, unmarked, with a letter of explanation. If you use a response sheet which has a different number from the subcourse you are working, your response will be graded against the wrong set of test items and you may receive a failing score.

c. STEPS IN PREPARING AND SUBMITTING YOUR EXAMINATION RESPONSE SHEET: Carefully follow the specific instructions printed in the INSTRUCTIONS block of your response sheet. Be sure you have marked one, and only one, response for each test item. For a TRUE-FALSE test item, mark A for true and B for false. Fold the response sheet just as it was folded when sent to you, place it in the self-addressed, franked envelope provided, and mail it to this center.

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EXAM	Petroleum Equipment and Technical Operations	1	75
	TOTAL	5	

LESSON 1 Credit Hours: 1

LESSON ASSIGNMENT

SUBJECT	Petroleum Equipment and Operations.
STUDY ASSIGNMENT	Lesson Text.
SCOPE	Bulk petroleum transporters and refuelers; gaging equipment; use of the fuel system supply point.
OBJECTIVES	As a result of successful completion of this assignment, you will be able to--

1. Identify the transporters and refuelers used by the US Army and describe the use of each of their major components.
2. Select the environmental factors that must be considered when choosing a site for a fuel system supply point.
3. Describe the purpose and use of the fuel system supply point.
4. Describe the use of gaging equipment.

II

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LESSON TEXT

1. GENERAL. The US Military Services are the major user of petroleum products in the world today. To transport these petroleum, oils, and lubricants (POL) products, trained personnel and specialized handling equipment are necessary. As an Army officer, you probably will not be required to operate petroleum handling equipment; however, you may be assigned to a petroleum supply company where you will supervise personnel engaged in petroleum handling operations. You may serve in a nondivisional unit in which your petroleum requirements are met by direct support units, or you may be assigned to a divisional unit to which petroleum tank vehicles are organic. In any of these assignments you will need to know something about the petroleum handling equipment used for transporting or storing bulk petroleum products. This equipment includes transporters, refuelers, and gaging equipment. You will need to be familiar, also, with the establishment and operation of the fuel system supply point. The fuel system supply point and petroleum handling equipment are described in this lesson text.

2. 2 1/2-TON FUEL-SERVICING TANK TRUCK. This truck has a carrying capacity of 1,200 gallons. From the front of the model M49A1C tank body to the rear, there are three compartments capable of carrying 200, 400, and 600 gallons, respectively. The later M49A2C (fig. 1) model is equipped with a stainless steel tank body that is divided into two compartments capable of carrying 600 gallons each. Each compartment has its own manhole and filler cover assembly (fig. 2), bottom pump discharge valve with screen, and drainpipe. The drainpipes connect into a manifold in the equipment compartment at the rear of the vehicle. The equipment compartment (fig. 3) houses an 80 gallons per minute (gpm) pump, a discharge valve control assembly, a manifold, a gravity delivery or suction gate valve, a vertically mounted filter/separator equipped with go-no-go fuses, and a meter and gage stick.

a. DELIVERY PUMP. A rotary-type positive displacement pump discharges fuel from the 1,200-gallon tank truck. The pump is rated at 80 gpm at 700 revolutions per minute (rpm); however, the meter limits the flow to 60 gpm. The pump is operated by a power takeoff through the front, intermediate, and rear drive shafts under the tank body. The power takeoff is controlled by a shift linkage from the cab of the truck. A speed control linkage for the truck engine regulates the engine's speed when the power takeoff is engaged for pumping fuel. The pump is equipped with a strainer for protection; this strainer should be removed and cleaned weekly. The pump does not require priming because gravity pulls the product into the pump from the tank compartments. However, initial priming is recommended to wet the rotating elements and seal clearances.

b. DISCHARGE VALVE CONTROLS. The discharge valve controls (one operating lever for each compartment) are mounted in the equipment compartment. The discharge valves are opened by pulling the levers toward the rear. The handle at the left front of the truck body when pulled, closes the discharge valves located in the bottom of tank compartments. In case of fire in the rear compartment, the spring-loaded, fusible link release lever will close all valves in the tank compartment bottom. Closing the compartment doors causes a safety bar to trip all lever-operated handles, thus insuring that all tank compartment bottom valves are closed.

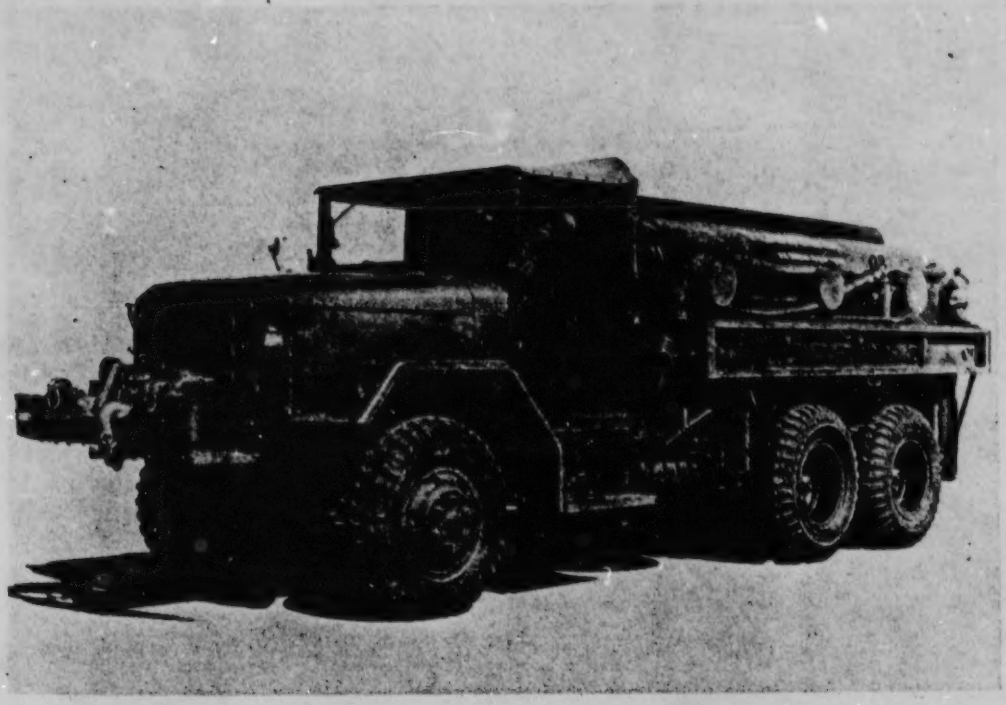

Figure 1. M49A2C fuel-servicing tank truck.

c. FILTER/SEPARATOR. The chief function of this element is to collect solid contaminants and separate water from the fuel. The upright Bendix filter/separator (fig. 4) is equipped with three filter elements and three go-no-go fuses. The fuses shut off the flow of fuel if water or solid contaminants exceed a safe level; this shutoff indicates that the filters are not operating properly. The cause must be found, and the fuses must be replaced before the operation continues. The unit is equipped also with a manual drain tube valve and a pressure gage operated by a three-way pressure valve. The manual drain tube valve must be kept closed during fueling operations. The pressure valve gage also reflects the condition of the filter/separator elements by indicating the difference between inlet, outlet and internal pressure. The automatic dump valve is float operated; the float sinks in gasoline and rises in water. When water is present, the float rises in the valve housing, the valve opens, and water drains through the valve drain tube. The pressure should be checked each day the equipment is used. When recorded and the differential pressure is excessive, the filter/separator elements should be replaced; they should be changed at least every 24 months or sooner if conditions indicate a change is necessary.

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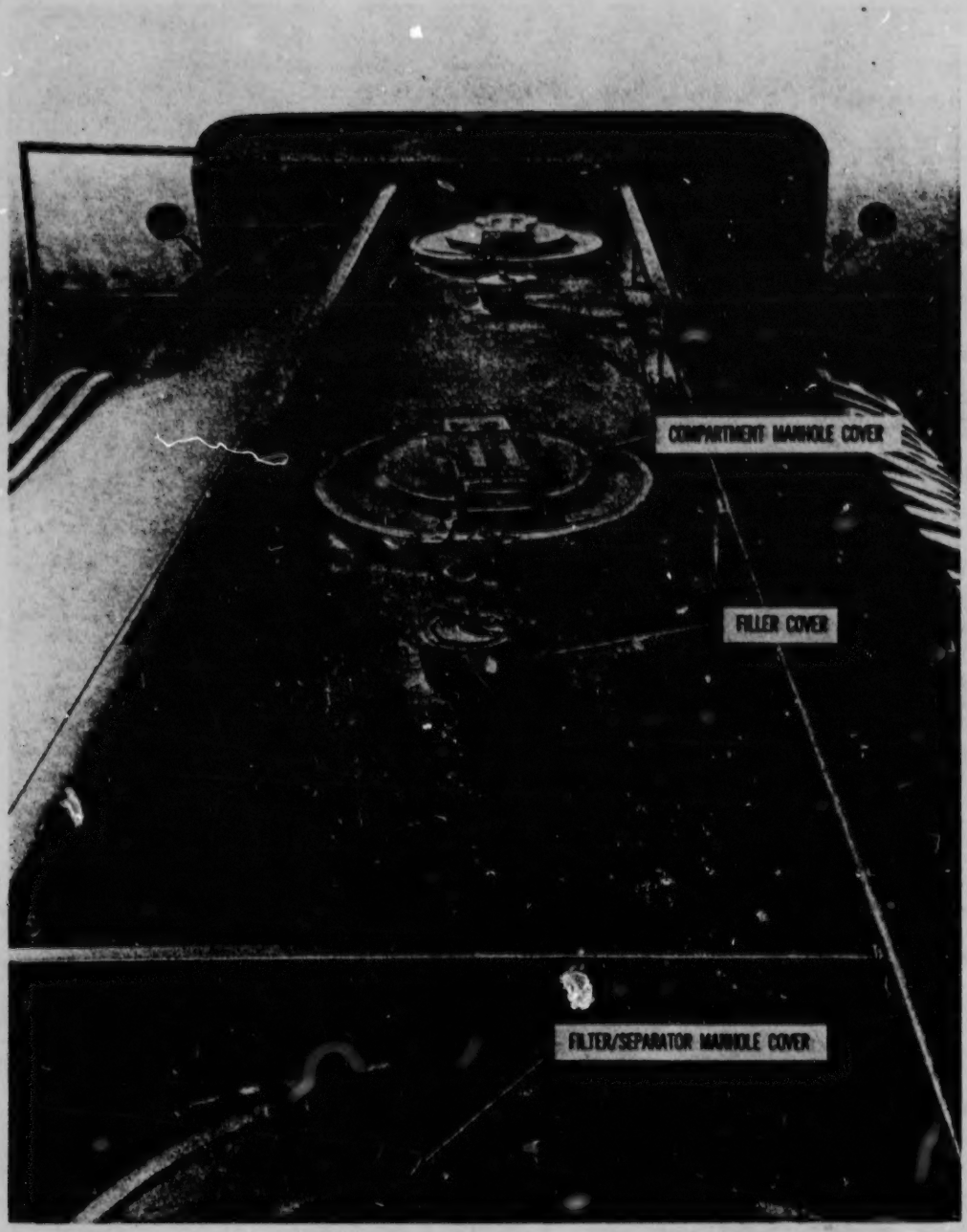


Figure 2. Manhole and filler covers of tank compartments.

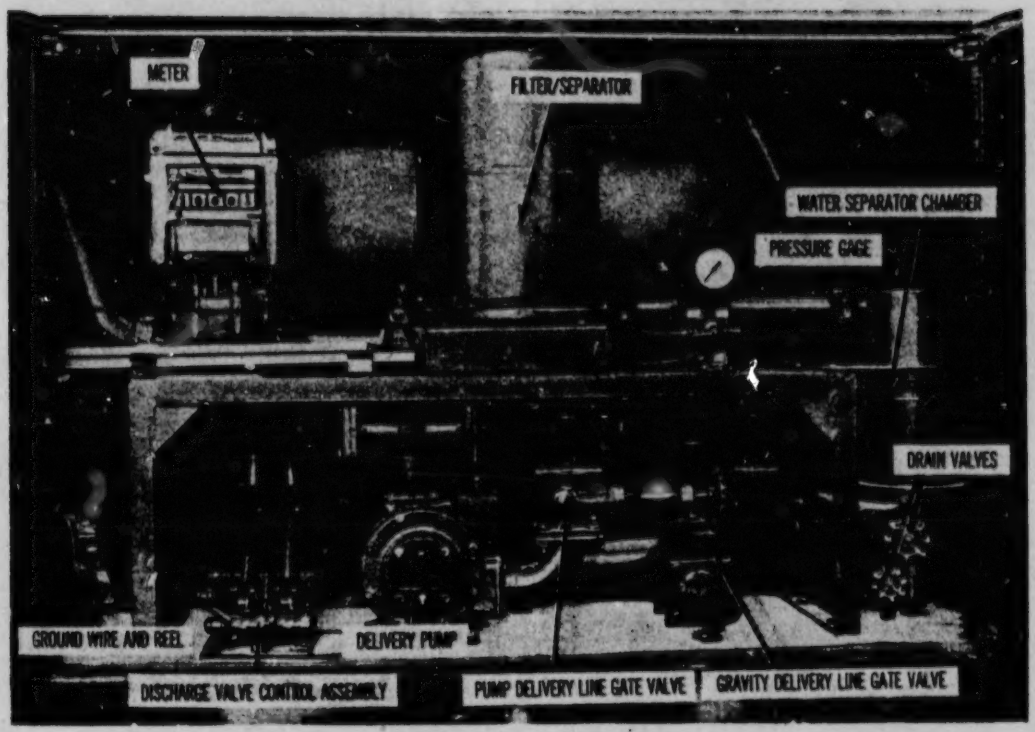
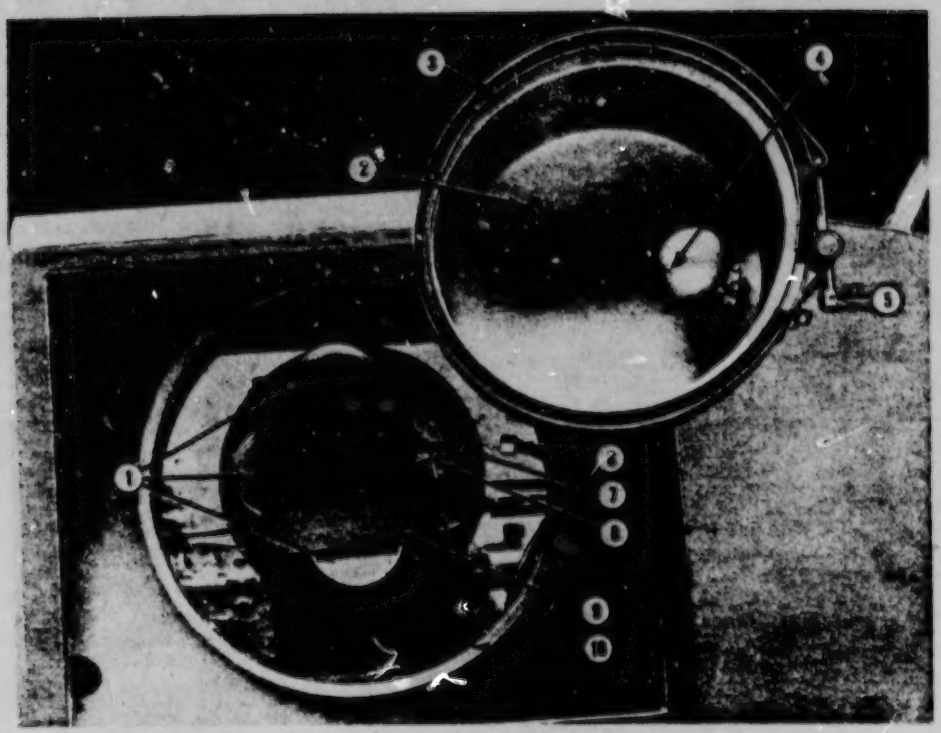


Figure 3. Rear equipment compartment of M49A2C tank truck.



1	Filter element canisters	6	Air vent line
2	Cover	7	Nuts and washers (3)
3	O-ring packing	8	Go-no-go fuses (3)
4	Valve	9	Support plate
5	V-bank coupling	10	Housing

Figure 4. Top view of filter/separator with manhole cover and filter/separator cover removed.

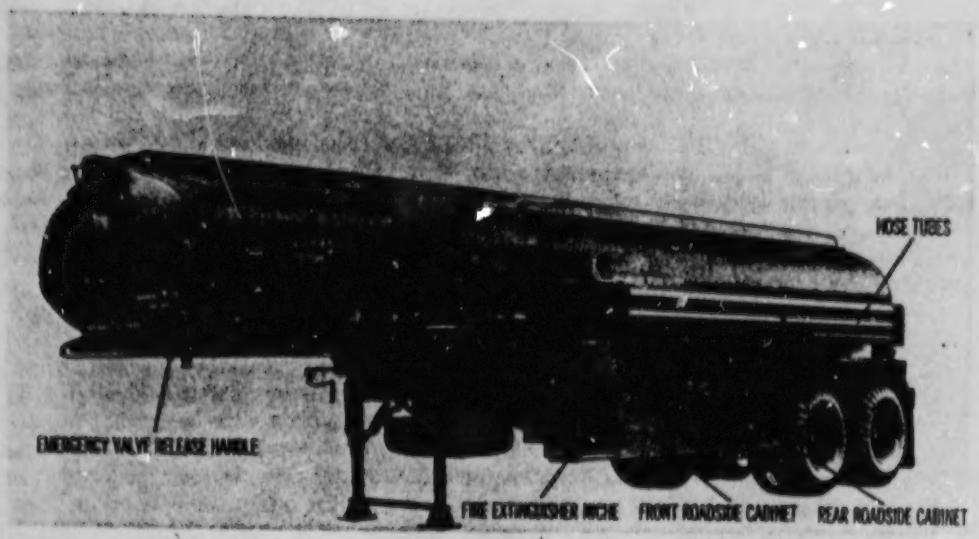
d. METER. The meter (fig. 3) is a positive displacement type rated at 60 gpm, it is designed to register total output. The meter assembly includes a meter-screen assembly, an air expansion chamber, and an air eliminator tank. The meter registers to 9,999 gallons, and a reset lever permits the meter to be run back to zero after individual refuelings. The meter must not be reset when the truck is refueling.

c. DISPENSING HOSE AND NOZZLE. The tank truck is equipped with a 35-foot length of 1 1/2-inch dispensing hose that contains an internal bonding wire. A 1 1/2-inch nozzle with a cone-shaped 100-mesh screen is attached to the end of the dispensing hose. The nozzle tube should be attached and tightened by hand only. The screen is removed by detaching the nozzle tube. An additional two 10-foot lengths of 1 1/2-inch gravity-dispensing hose is located on the left side of the rear storage compartment.

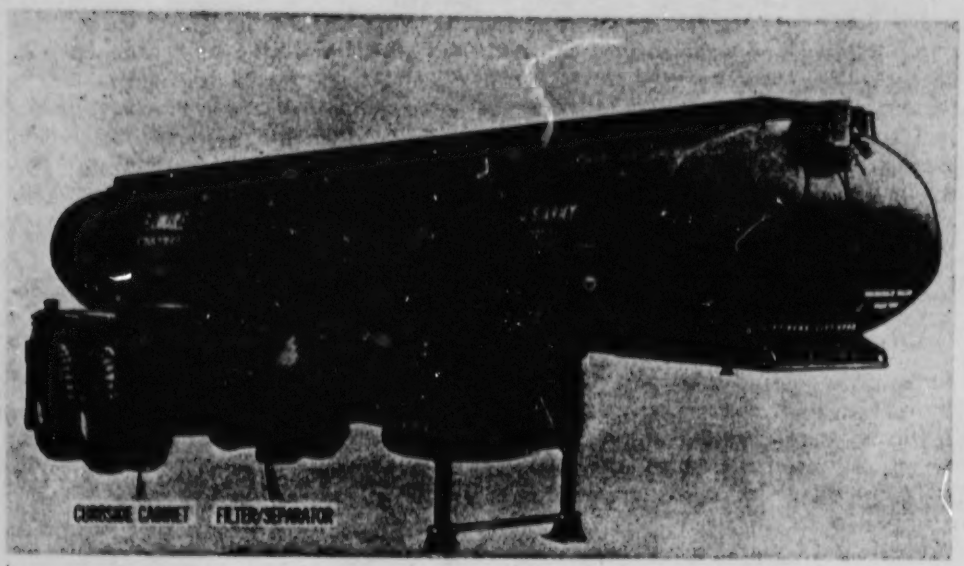
3. 5,000-GALLON FUEL-SERVICING TANK SEMITRAILER. The 5,000-gallon semitrailer (fig. 5) is available with or without a filter/separator. The suffix C in the model number indicates the semitrailer is equipped with a filter/separator (model number M131A3C, M131A4C, and M131A5C). These models are known as fuel-servicing tank semitrailers and may be used for refueling aircraft. The models without the filter/separator (M131A2, M131A4, and M131A5) are used for line hauls between storage facilities where the product may be filtered at the storage location. The M131A3C, M131A4C, and M131A5C models have the following components; these components are not always identical on the different models of the semitrailer.

a. TANK COMPARTMENTS. The M131A3C and the M131A4C models have four 1,250-gallon compartments, and the M131A5C has two 2,500-gallon compartments. The compartments of the M131A3C model are coated with either a zinc oxide or a plastic substance. The M131A4C and M131A5C tanks are constructed of stainless steel and do not require a coating. Each compartment has a removable manhole cover and filler cap with vent valve, two-way gage markers for cross-country and highway travel, and an emergency valve and drainpipe. The manhole covers can be reached from a walkway on top of the tank; the tank is filled by lifting the filter cover on top of the manhole. A manifold allows the product to be distributed to or received from each of the tank compartments. Each model vehicle has its own manifold designed to meet its own requirement.

b. MANIFOLD AND EMERGENCY VALVE CONTROLS. The manifold with its four compartment manifold valves is used to distribute the POL product to and from each of the tank compartments. The manifold is located in the forward cabinet (fig. 6) on the curbside of the trailer; some models have the cabinet on the roadside, and others have it on the curbside. The emergency valve control is located in the same cabinet as the manifold.



ROADSIDE VIEW.



CURBSIDE VIEW.

Figure 5. Model M131A4C 5,000-gallon semitrailer.

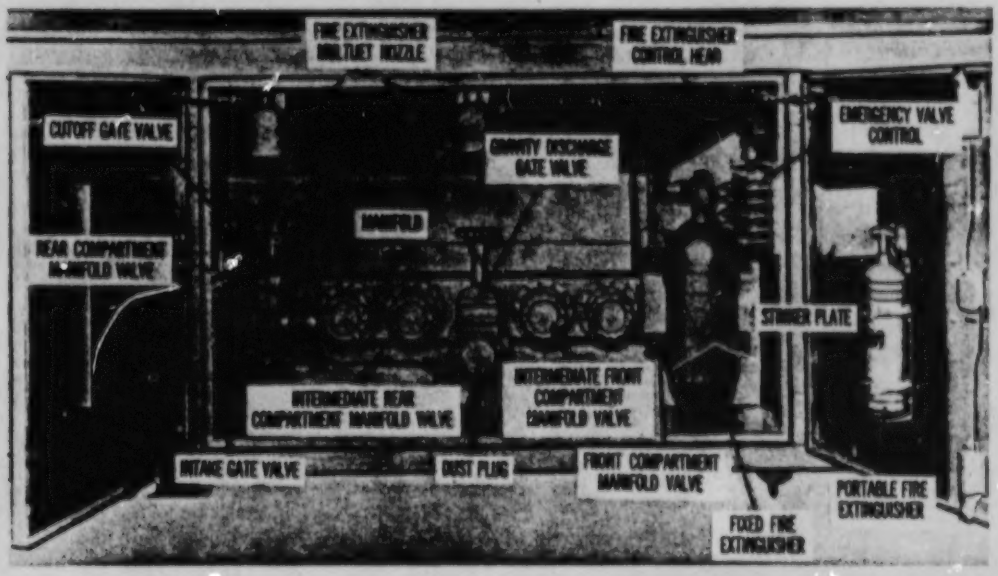


Figure 6. Equipment in forward curbside cabinet of M131A3C and M131A2 tank semitrailer.

c. PUMP. Each semitrailer is equipped with a self-priming centrifugal pump to load and unload the product in the tank. The pump is capable of pumping 250 gpm. The pump is located in the forward portion of the curbside cabinet.

d. METER. A Brodie 300-gpm positive displacement meter (fig. 7) is located on the left in the roadside cabinet of model M131A3C, M131A4C and M131A5C. The meter is connected by a four-way valve to the dispensing hose and reel. Fuel flows from the filter/separator through the meter and out through the dispensing hose.

e. FILTER/SEPARATOR. The filter/separator removes solid contaminants and water from the product. Water is drained off into a sump at the bottom of the separator and is released by an automatic drain-off valve. The filter/separator contains equipment for checking pressure differential across the filter element. A drop in pressure may be an indication that the filter element needs changing. The filter/separator is located forward of the curbside cabinet.

f. FIRE EXTINGUISHING EQUIPMENT. The M131A3C, M131A4C, and M131A5C semitrailers have two types of firefighting equipment: a fire extinguisher system and portable extinguishers.

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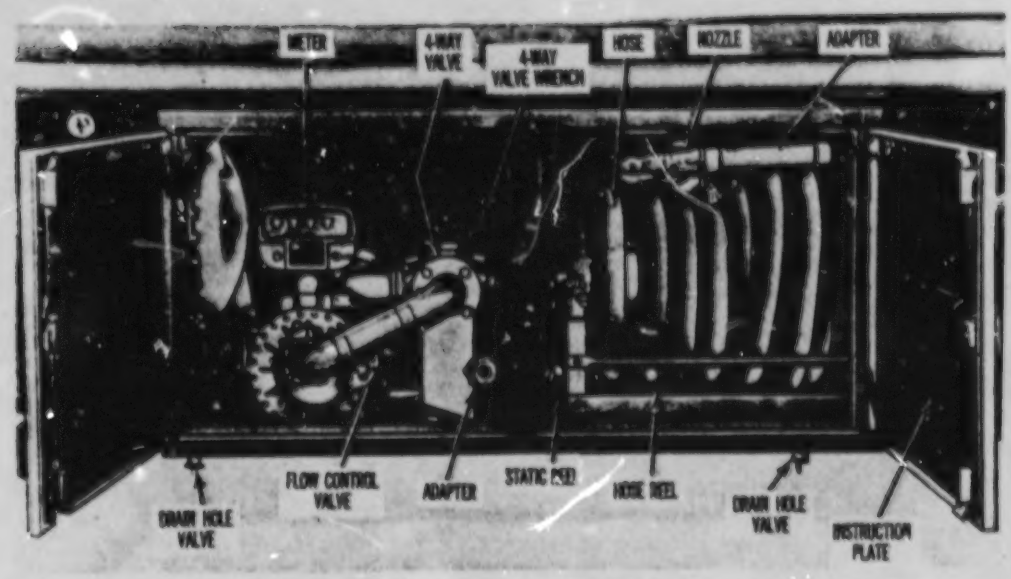


Figure 7. Equipment in roadside cabinet of M131A3C tank semitrailer.

(1) M131A3C MODEL. The fire extinguishing system of the M131A3C semitrailer is composed of a 10-pound, fixed, carbon dioxide cylinder; three multijet nozzles; a control head; and a remote control. The cylinder is mounted to the right of the forward curbside equipment cabinet. Its nozzles are mounted above and directed at the manifold inside the cabinet. The system can be operated from the control head at the right of the emergency valve control or from the remote control located at the fire extinguisher niche to the right of the curbside equipment cabinet. The portable extinguishers provided are two 1-quart fire extinguishers, mounted on the curbside equipment cabinet doors, and a 15-pound extinguisher mounted in the fire extinguisher niche at the right of the curbside equipment cabinet.

(2) M131A4C AND M131A5C MODELS. The fire extinguishing system used on the M131A4C and M131A5C is composed of a 10-pound carbon dioxide cylinder, three nozzles, a control head, and a remote control. The cylinder is mounted in the roadside cabinet. Two nozzles are mounted above and directed at the equipment in the roadside cabinet; the third nozzle is mounted in the curbside cabinet, above the engine. Three portable fire extinguishers are provided: two 1 1/2-pound models and one 15-pound model. The 1 1/2-pound extinguishers are mounted in brackets on the roadside cabinet doors. The 15-pound extinguisher is mounted either inside the cabinet or in a niche near the cabinet. Follow directions on the data plates for operation and care.

4. TANK CARS. Tank cars used for petroleum products usually have one compartment and are capable of carrying from 6,000 to 13,000 gallons of product. Some tank cars are divided into several compartments and may transport more than one product at a time.

a. DOME. Each tank car compartment has a dome (fig. 8) to allow space for product expansion resulting from a rise in temperature; thus the compartment can be filled to full shell capacity. Each dome has a manhole through which the compartment may be loaded, unloaded, inspected, cleaned, and repaired. Dome covers may be either the hinged and bolted type or the screw type. Domes are usually equipped with vents and safety valves through which accumulated vapors can escape (fig. 8).

b. SAFETY VALVE. The safety valve used on most tank cars consists of a poppet valve, spring-loaded to a predetermined pressure when pressure in the dome exceeds the pressure setting, the valve is forced off the valve seat and the excess vapor can escape. When the pressure drops to a level equal to the valve setting, the spring automatically closes the valve.

c. BOTTOM OUTLET. Each compartment is equipped with a bottom outlet, and the compartment is usually unloaded through this outlet (fig. 9). The outlet valve is controlled by a valve-rod handle or valve-rod handwheel (fig. 10) located inside the dome. Outlets on tank cars used in the United States are 5 inches in diameter; outlets on tank cars used overseas are generally 4 inches in diameter. To adapt the pump suction line to the 5-inch outlet, a tank car elbow assembly is used. For 4-inch outlets, a 4- by 5-inch adapter must be installed between the elbow assembly and the tank car outlet. If the bottom outlet is inoperable or fittings are not available, the tank car may be unloaded through the dome.

5. FUEL SYSTEM SUPPLY POINT. The fuel system supply point is designed to receive, store, and issue petroleum products under varying conditions. It can be set up at one location, moved to another location, and set up for operation there without serious interruption of service. The fuel system can be used at terminals and depots, at class III supply points, and at division distributing points to provide storage facilities, to supplement fixed storage facilities, to transfer bulk fuel from one means of transportation to another, or to provide dispensing facilities for bulk reduction or delivery of product to using vehicles. Supply and service companies and petroleum supply and operating companies are authorized to use this system.

a. DESCRIPTION. The fuel system is made up of a receiving manifold, two trailer-mounted centrifugal pumping assemblies, two filter/separators, six collapsible storage tanks, six bottom loading points, two drum filling points, six vehicle refueling points, approximately 1,200 feet of discharge hose, 1,200 feet of suction hose, and tools and accessories. The main components of the system are described below.

(1) CENTRIFUGAL PUMPS. Each of the two centrifugal pumps consists of a pump assembly and an engine assembly (fig. 11); they are mounted on trailers and may be towed by a 1/4-ton truck. The pumps are capable of pumping 350 gallons per minute and may be used either to receive or to deliver the product; they are usually arranged with one pump receiving and the other delivering.

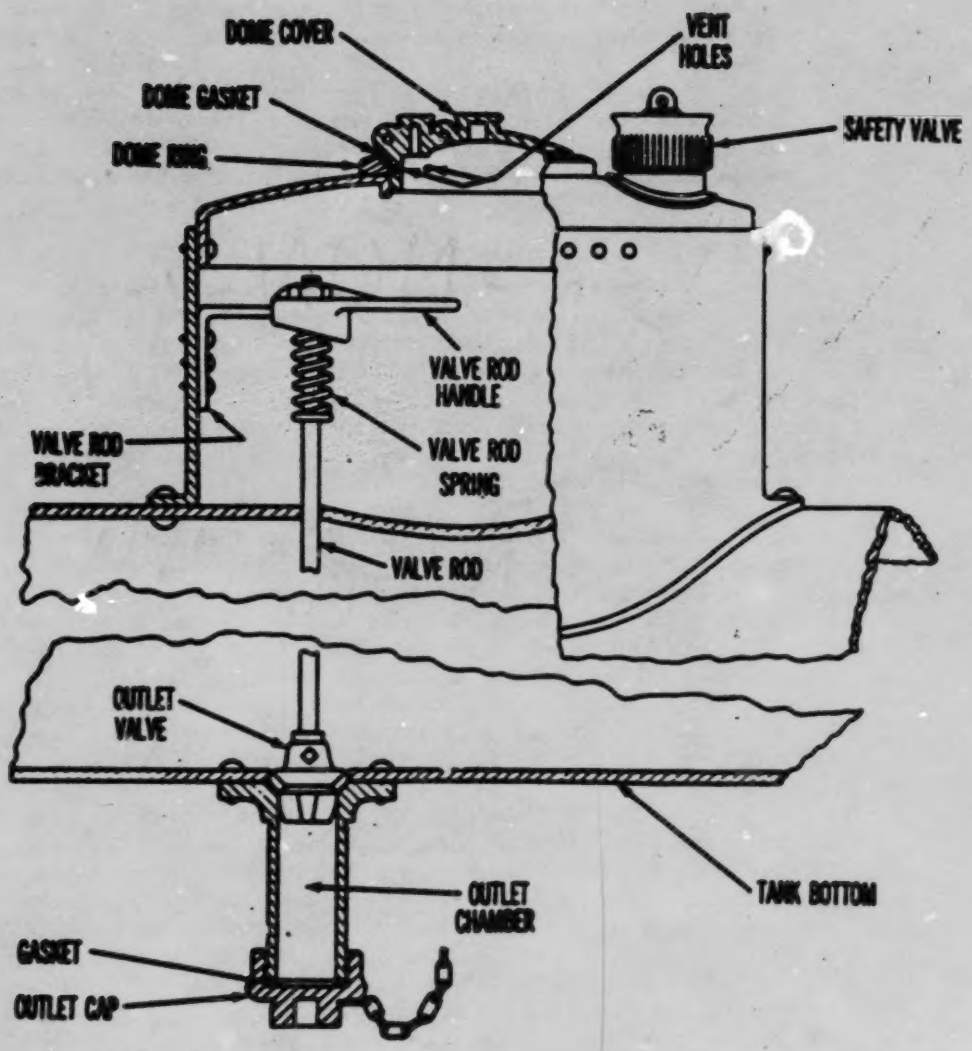


Figure 8. Tank car dome and bottom outlet.

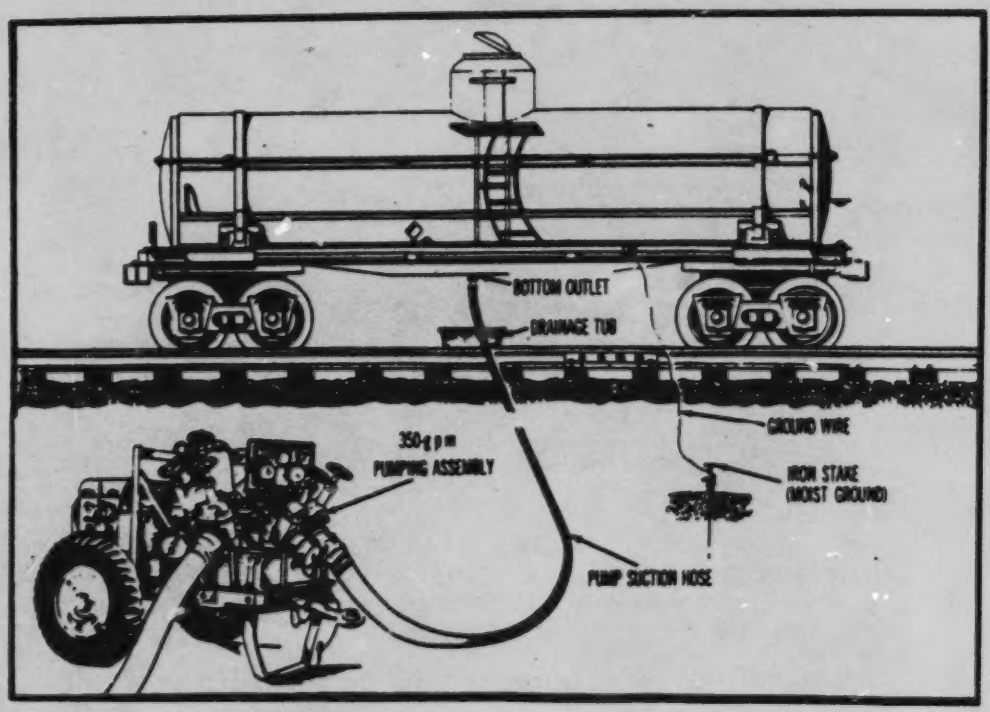


Figure 9. Tank car unloading through bottom outlet.

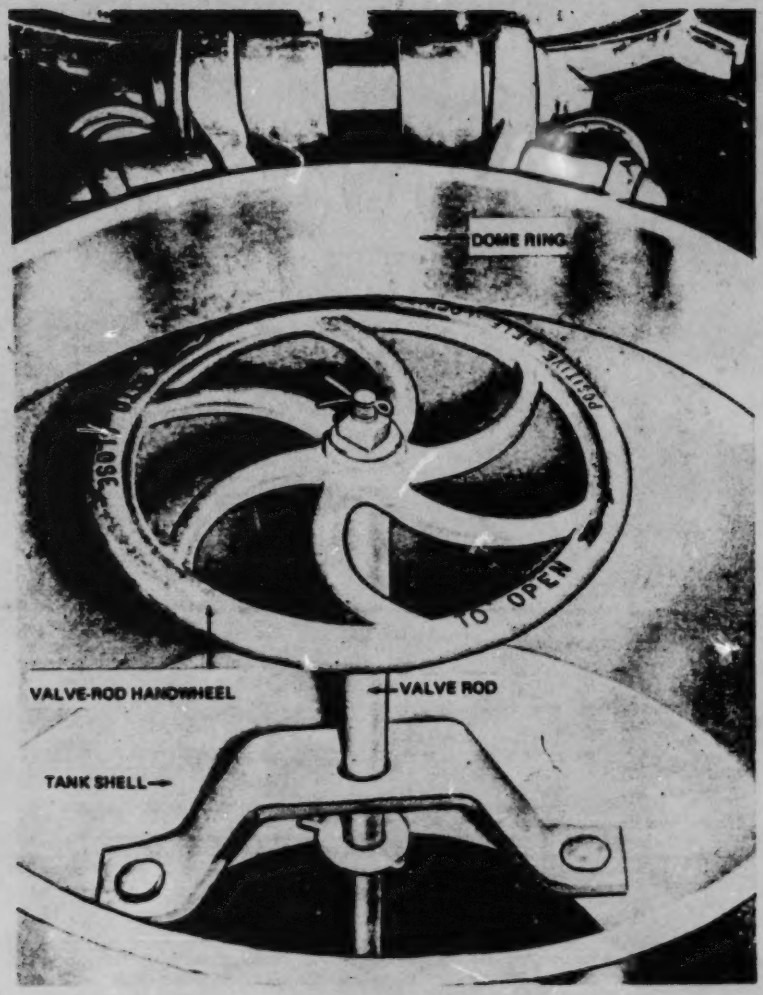
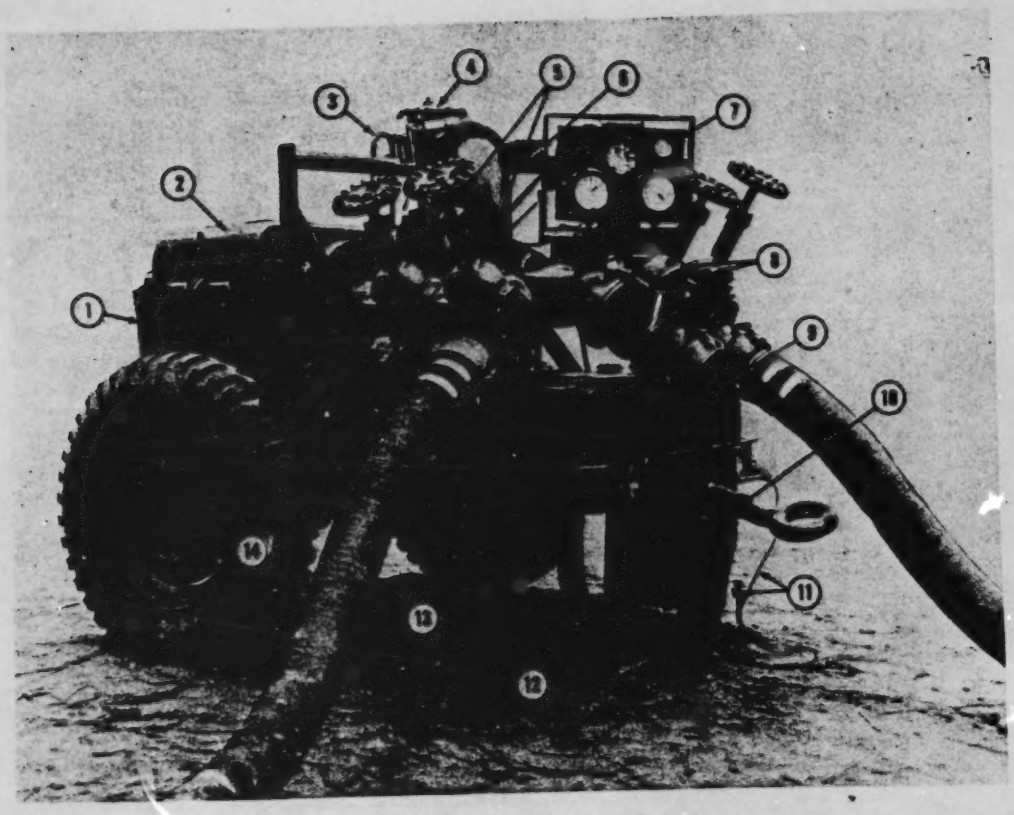


Figure 10. Tank car dome interior showing valve-rod handwheel.

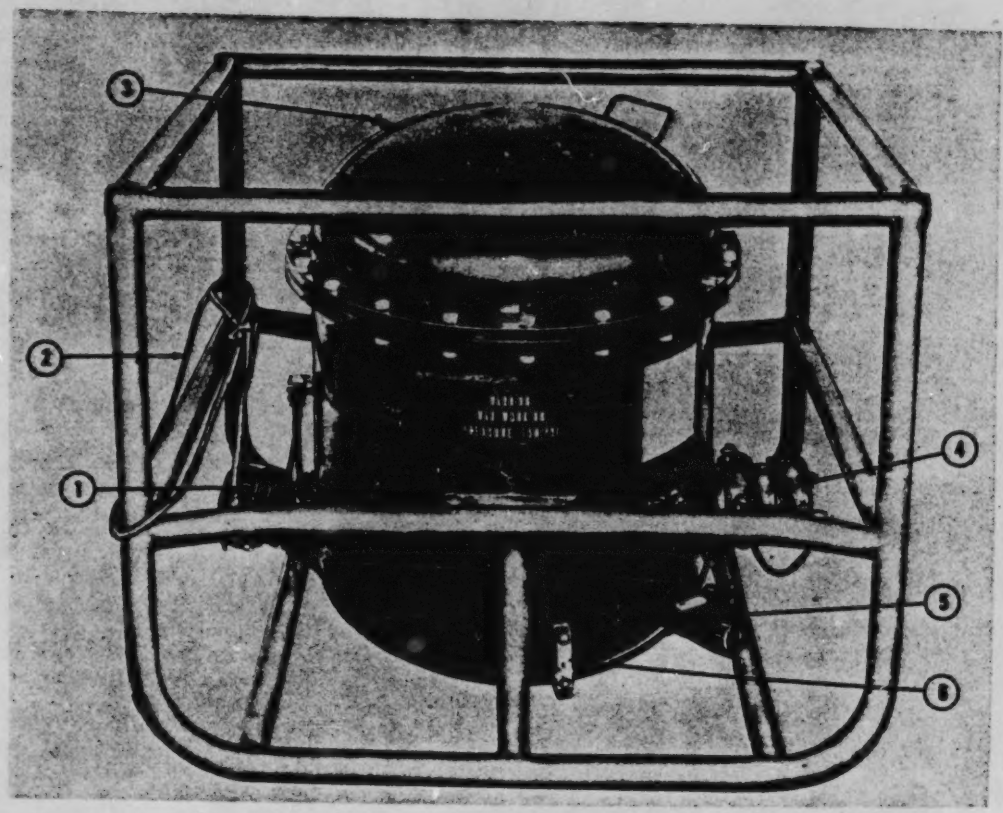
(2) FILTER/SEPARATORS. The system consists of two skid-mounted filter/separators (fig. 12) that are usually connected parallel on the delivery side of the system to remove water and solid contaminants from the product before it is dispensed into the vehicles or containers.

(3) 10,000-GALLON COLLAPSIBLE TANKS. The system contains six 10,000-gallon collapsible tanks (fig. 13). Each tank is constructed of two-ply synthetic-rubber-impregnated nylon fabric and furnished with a filler assembly, an access door assembly, an overflow assembly, and a drain plug.



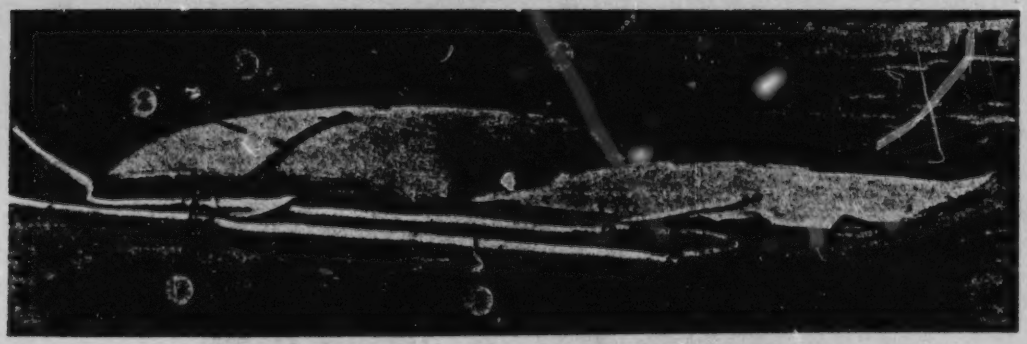
1	Air cleaner	8	Suction valves
2	Engine air shroud	9	Fuel tank
3	Lifting eye	10	Towbar
4	Air/vapor eliminator	11	Bonding cable and ground rod
5	Discharge valves	12	Retractable support
6	Throttle control	13	Strainer
7	Instrument panel	14	Toolbox

Figure 11. 350-gpm pumping assembly.



1	Inlet	4	Outlet
2	Grounding cable	5	Water drainoff
3	Air eliminator	6	Sight glass

Figure 12. 350-gpm filter/separator.

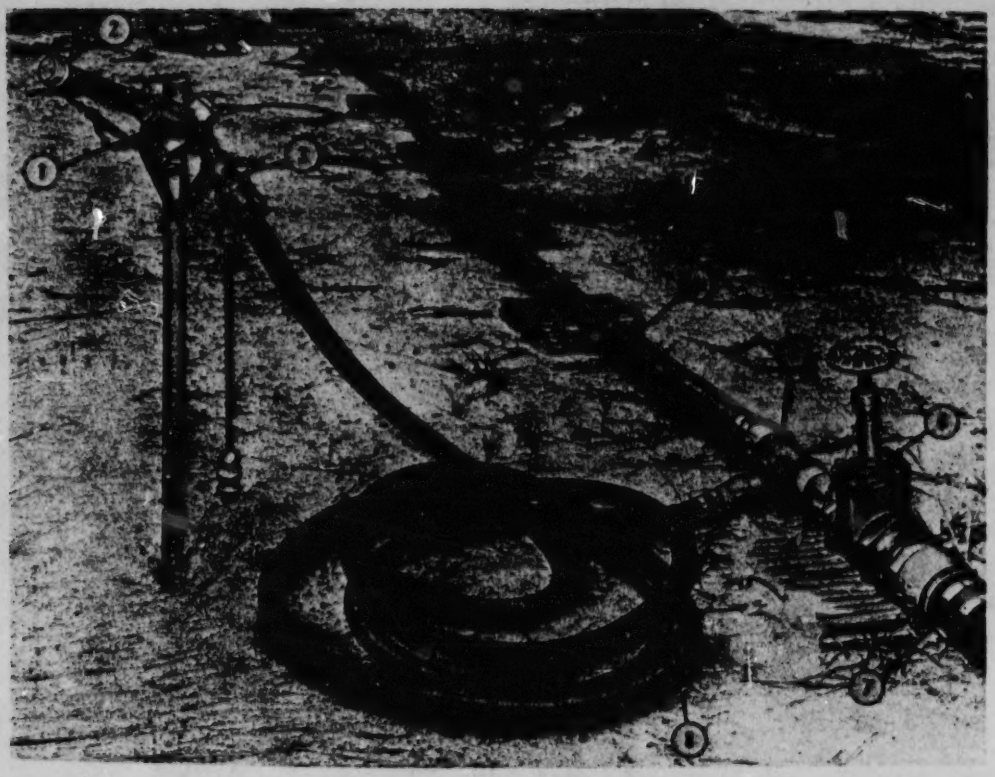


1 4-inch gate valves
2 Fill/discharge line
3 Vent pipe pressure relief assembly
4 Carrying handle
5 4-inch manifold hose

Figure 13. 10,000-gallon collapsible tank.

(4) VEHICLE-REFUELING AND DRUM-FILLING POINTS. The system has six nozzles for refueling vehicles or filling 55-gallon drums and cans (fig. 14). Also provided are two 1 1/2-inch hoses used for filling 500-gallon drums.

b. SITE SELECTION. The site for the fuel system supply point should be convenient both to receive fuel and dispense it. The location chosen may be near other related fuel systems, or near roads, railways, airfields, or beaches. The terrain must also be considered. A large area of level ground is necessary; the area should be large enough for the storage tanks to be safely spaced. It is a good practice to space the tanks so that all hose is used. The tanks themselves require a large area. The older type of rectangular tank is 40 feet long and 11 feet wide; the newer type tank is 22 feet square. If possible, the system should be located where trees or other natural cover can conceal it.



1	1-inch aluminum nozzle	6	3-inch gate valve, 3-inch inlet to 2-inch outlet (supply line)
2	Nozzle cap	7	3-inch discharge hose (supply line)
3	Coupling half	8	1-inch discharge hose, 25 feet long
4	2-inch discharge hose		
5	T-coupling, 2-inch run to 1-inch lateral		

Figure 14. Drum and can filling and vehicle refueling point.

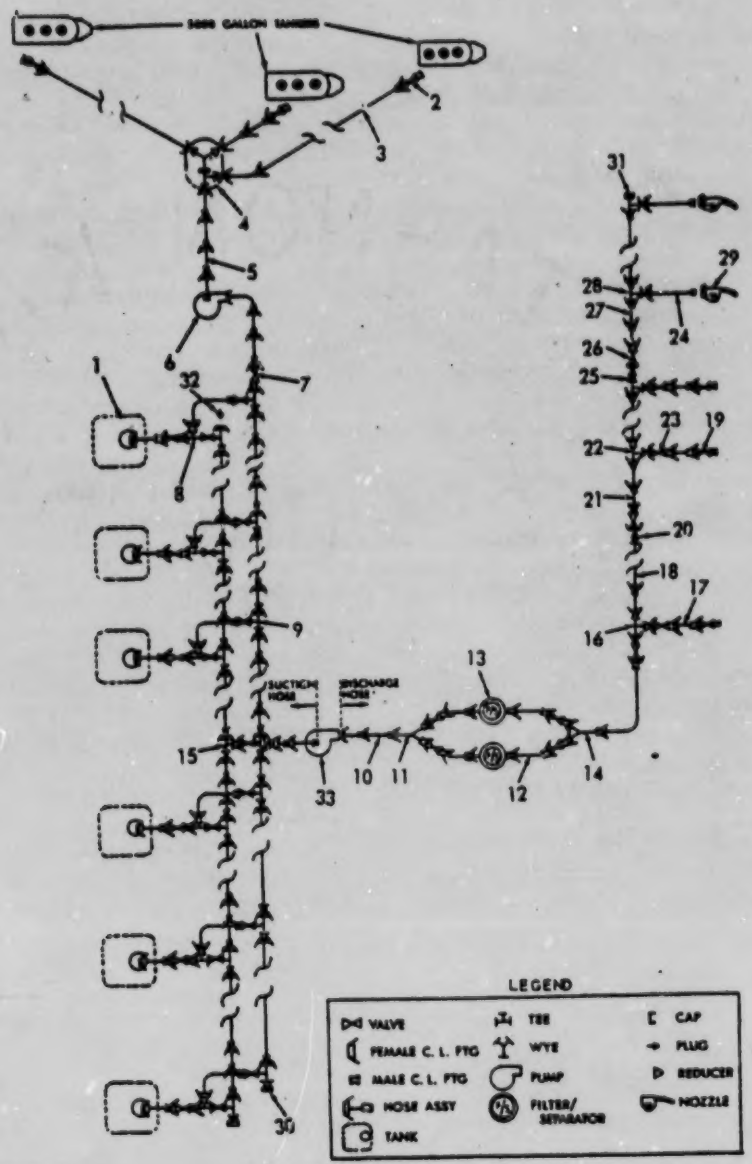
c. LAYOUT. The equipment may be arranged in one of several different layouts depending on the terrain and the assigned mission. Figure 15 illustrates a typical arrangement for dispensing one type of product. The product enters the receiving manifold from highway transporters, railway tank cars, pipeline, hoseline, or a combination of these sources. The product may move under positive pressure from transporters, pipeline, or hoseline, but usually one of the two 350-gpm pumping assemblies is used to distribute the product through one side of the hoseline manifold to the six 10,000-gallon collapsible tanks. The other pumping assembly is used as a delivery pump; it draws fuel from the tanks, through the other side of the hoseline manifold, and discharges it through the filter/separators into a line leading to the bottom loading points and into a hose header system of the can and drum refueling points. The product can also be drawn from the source of supply for direct discharge through the bottom loading points or hose header nozzles, bypassing storage entirely. The equipment can also be arranged to receive and dispense two different types of fuel (fig. 16). In this arrangement, the pumping assembly for each fuel receives and disburses that fuel. The receiving manifold, in this case, is connected into both sides and may receive both fuels at the same time.

6. GAGING EQUIPMENT. Gaging petroleum products includes measuring the temperature and the depth of the POL product and the amount of bottom sediment and water. The instruments used for these purposes are explained below.

a. CUP CASE THERMOMETER. The volume of liquid products changes in direct proportion to the temperature. Therefore, to get an accurate measurement of the volume of a product the temperature of the product must be taken at the time of gaging. The cup case thermometer, so named because of the cup case mounted at its bottom, is used for this purpose. The thermometer is secured to a gage tape or cord and is lowered to the desired level. When the thermometer is withdrawn from the tank, the cup contains some of the liquid; this makes it possible to get a more accurate reading. Tables that specify the level at which the reading should be taken (in relation to the depth of the product) are available. The temperature reading for depths of 10 feet or more must be taken at more than one level. For example, the temperature must be measured at 5 feet below the top, 5 feet above the bottom, and in the middle when the depth is 20 feet or more. The three readings are then averaged.

b. TAPE AND BOB. The tape and bob is used to determine the amount of product in a tank. It consists of a steel tape connected to either an innage or an outage bob. The innage bob is used to measure the distance from the bottom of the tank to the surface of the product; it may also be used to measure outage. The outage bob is used to measure the distance from a reference point at the top of the tank to the surface of the product. The outage bob has deep grooves that make it adaptable for gaging both heavy and light products. The tape and bobs are used as illustrated in figure 17.

c. PETROLEUM GAGE STICK. A petroleum gage stick is used to determine innage of a small horizontal tank, a nonpressure tank car, or a tank truck. The stick is constructed of hardwood or other suitable material and is long enough to gage the height of a tank. The stick is usually about 10 feet long for a tank car. The reading is taken by measuring the distance from the bottom of the tank to the surface of the product (fig. 18).



1	Tank (10,000 gallon)	12	Discharge hose (4" x 25') (6)	23	Quick-acting valve (1½)
2	Gate valve (3")	13	Filter/separator (350 GPM, 4")	24	Discharge hose (1" x 25') (6)
3	Suction hose (3" x 12') (16)	14	Wye assembly (4")	25	Reducer (3")
4	Wye and tee assembly	15	Tee assembly (4")	26	Quick-acting valve (2")
5	Suction hose (4" x 10') (35)	16	Tee assembly (4" x 3")	27	Discharge hose (2" x 25') (7)
6	Pump (350 GPM, 4", receiving)	17	Discharge hose (1½" x 25') (5)	28	Reducing tee (2")
7	Gate valve (4")	18	Discharge hose (3" x 25') (7)	29	Nozzle (1", with adapter)
8	Manifold (with 2 tee fittings)	19	Quick-acting valve (3")	30	Dust cap (4")
9	Manifold (with 1 tee fitting)	20	Reducer (4")	31	Dust cap (2")
10	Discharge hose (4" x 50') (5)	21	Discharge hose (3" x 50') (5)	32	Dust plug (4")
11	Wye assembly (4")	22	Tee assembly (3" x 1½")	33	Pump (350 GPM, 4", dispensing)

Figure 15. Basic layout of the fuel system supply point.

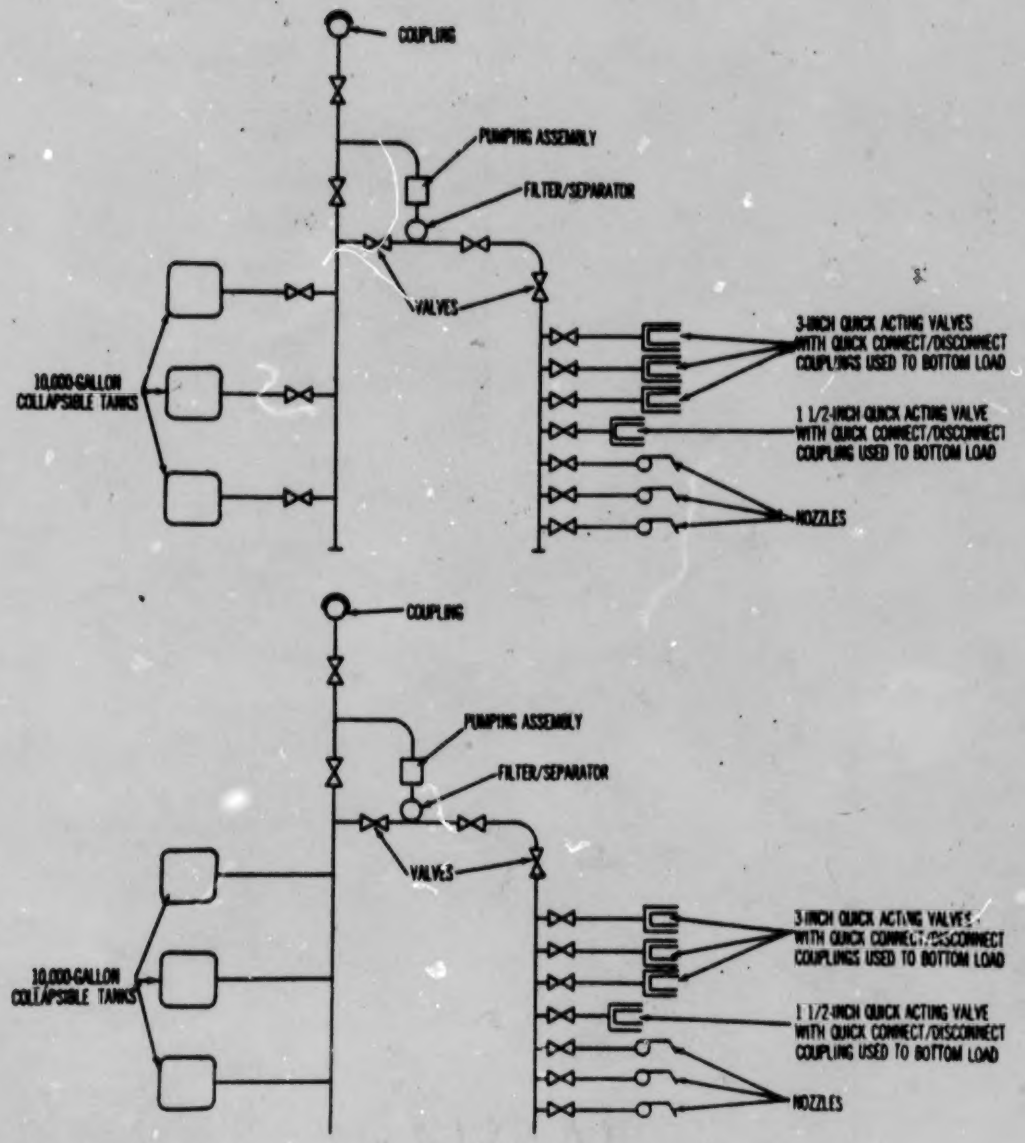

COUPLING
PUMPING ASSEMBLY
FILTER/SEPARATOR
VALVES
3-INCH QUICK ACTING VALVES WITH QUICK CONNECT/DISCONNECT COUPLINGS USED TO BOTTOM LOAD
1 1/2-INCH QUICK ACTING VALVE WITH QUICK CONNECT/DISCONNECT COUPLING USED TO BOTTOM LOAD
NOZZLES
10,000-GALLON COLLAPSIBLE TANKS
COUPLING
PUMPING ASSEMBLY
FILTER/SEPARATOR
VALVES
3-INCH QUICK ACTING VALVES WITH QUICK CONNECT/DISCONNECT COUPLINGS USED TO BOTTOM LOAD
1 1/2-INCH QUICK ACTING VALVE WITH QUICK CONNECT/DISCONNECT COUPLING USED TO BOTTOM LOAD
NOZZLES
10,000-GALLON COLLAPSIBLE TANKS

Figure 16. Suggested fuel system layout for handling two different fuels.

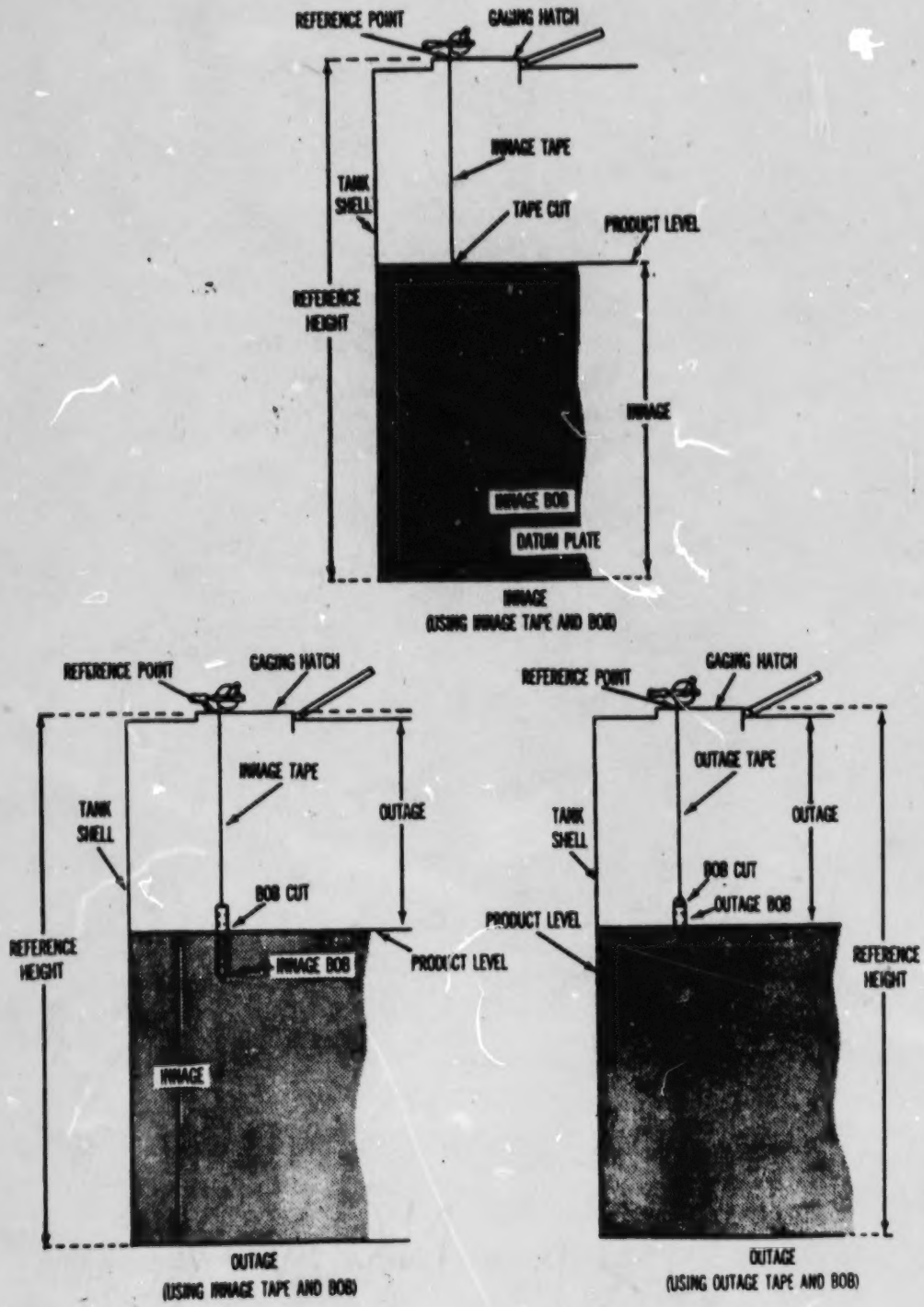


Figure 17. Gaging with innage and outage tapes and bobs.

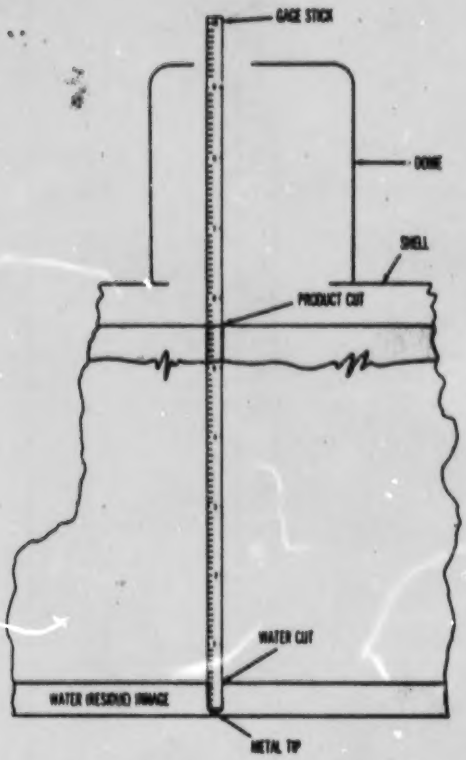


Figure 18. Position of petroleum gage stick when determining innages.

d. TANK CAR GAGE STICK. The tank car gage stick is used for determining tank car dome innages and shell outages. The stick is 36 inches long and has a metal angle attached at the zero point so the stick may rest on the tank shell at the gaging reference point of the tank car (fig. 19). It has two scales with a common zero 12 inches from the lower end, graduating upward and downward. The lower figures are used to measure shell outages and the upper figures are used to measure dome innages (fig. 20).

35

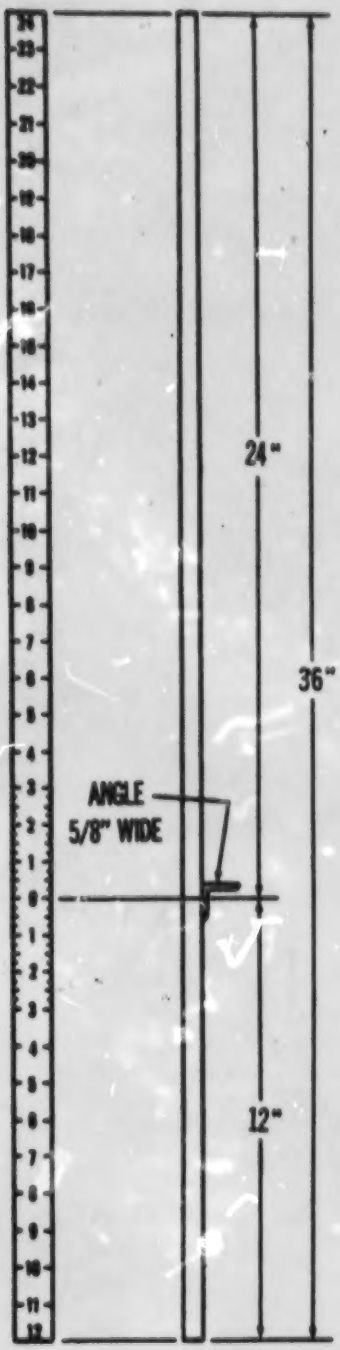


Figure 19. Diagram of tank car gage stick.

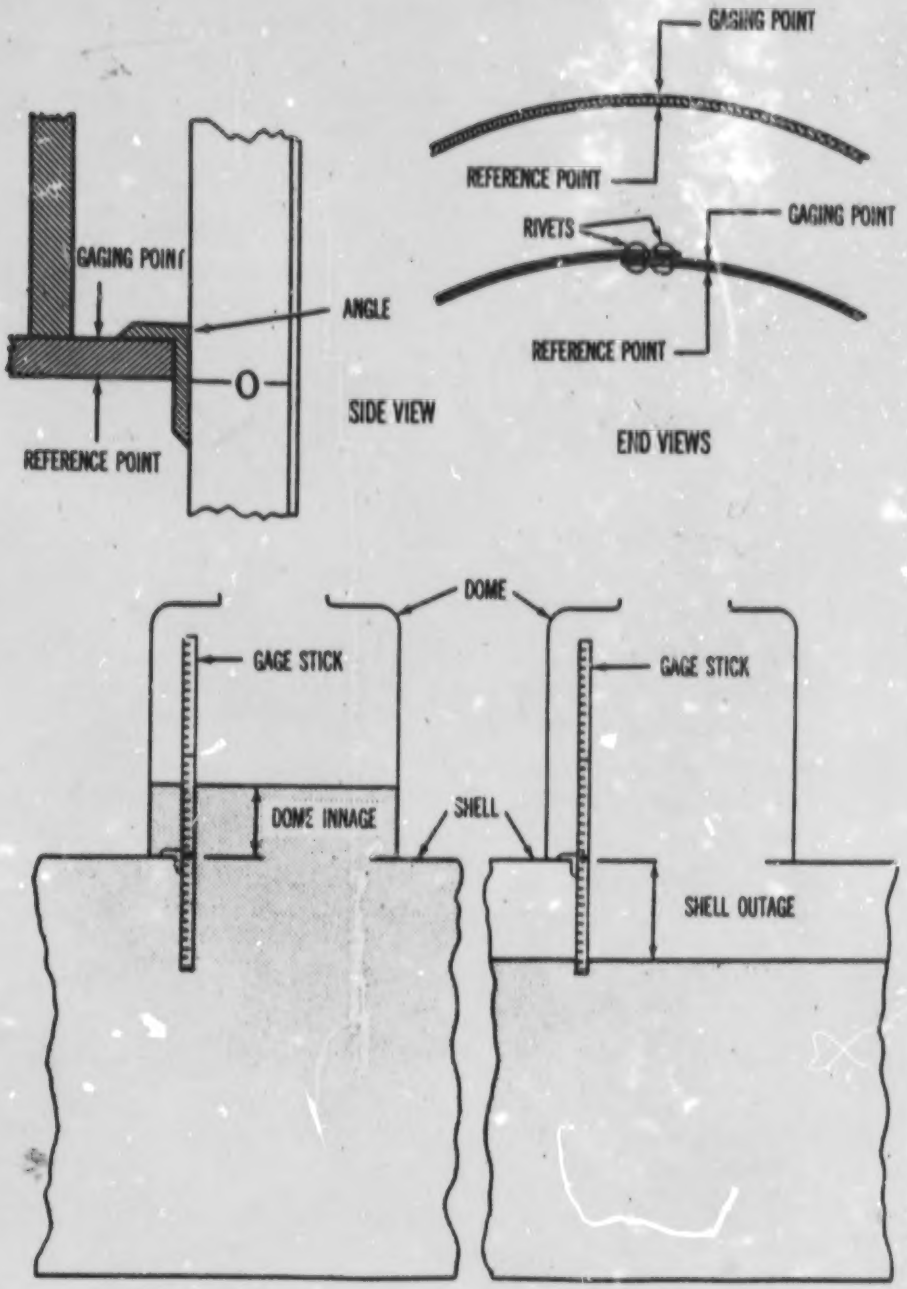


Figure 20. Use of tank car gage stick to determine dome innage and shell outage.

PROGRAMED REVIEW

The questions in this programed review give you a chance to see how well you have learned the material in lesson 1. The questions are based on the key points covered in the lesson.

Read each item and write your answer on the line or lines provided for it. Please use a pencil to write your answers. If you do not know, or are not sure, what the answer is, check the paragraph reference that is shown in parentheses right after the item; then go back and study or read once again all of the referenced material and write your answer.

After you have answered all of the items, check your answers with the Solution Sheet at the end of this lesson. If you did not give the right answer to an item, erase it and write the correct solution in the space instead. Then, as a final check, go back and restudy the lesson reference once more to make sure that your answer is the right one.

A1. The manifold and manifold valves of the M49-series tank trucks make it possible to distribute POL product ____, and _____ each tank compartment. (para 2b)

A2. An excessive difference between the inlet pressure and outlet pressure on the pressure gage of the filter/separator indicates that the _____ _____ need changing. (para 2c)

A3. When you see the suffix C on the model number of the 5,000-gallon fuel-servicing tank semitrailer, you know that it is equipped with a _____/_____. (para 3)

A4. One of the characteristics of the M131-series fuel-servicing semitrailers is that, in an emergency, all compartment bottom outlet/inlet valves may be closed by shutting the door of the forward curbside cabinet or by pulling the emergency valve located at the _____ of the trailer. (para 3b)

A5. What is the purpose of the dome on the tank car? _____ _____ _____ _____. (para 4a)

A6. The three uses of the fuel system supply point are to receive, store and _____ POL products. (para 5)

A7. The fuel system can be used at a number of places, one of which is at terminals and _____. (para 5a)

A8. In the list of the environmental factors below, check the ones preferred in locating a fuel system supply point. (para 5b)

_____ fairly level ground

_____ hilly territory

_____ area large enough to use all hose

_____ compact area requiring hose to be coiled

_____ natural cover

_____ treeless land

A9. When the fuel system supply point is arranged to disperse two types of fuel, each of the two pumping assemblies is used for both _____ and _____. (para 5c)

A10. At the time of gaging, the cup case thermometer is used to determine the temperature of a POL product to calculate the _____. (para 6a)

A11. When using a tape and an innage bob to determine innage volume measurement, you measure the distance between the bottom of the tank and the _____ of the product. (para 6b)

A12. When using a tape and an outage bob to determine outage volume measurement, you gage the distance from the surface of the product to the _____ of the tank. (para 6b)

A13. The innage of small horizontal tanks, nonpressure tank cars, and tank trucks may be gaged with a 10-foot _____ _____ stick. (para 6c)

A14. A 36-inch tank car gage stick is used to measure tank car _____ innages and _____ outages. (para 6d)

DO YOU UNDERSTAND EVERYTHING IN THIS PROGRAMED REVIEW? HAVE YOU CHECKED YOUR RESPONSES, MADE CORRECTIONS, AND RESTUDIED THE TEXT, IF NECESSARY? IF YOU HAVE, GO ON TO THE NEXT STUDY UNIT OF THIS SUBCOURSE.

APPENDIX

REFERENCES

FM 10-18	Petroleum Terminal and Pipeline Operations
FM 10-67	Petroleum Supply in Theaters of Operations
TM 10-70	Inspecting and Testing Petroleum Products
TM 10-1101	Petroleum Handling Equipment and Operation
TM 10-1113	Petroleum Tank Vehicle Operation
TM 10-4930-203-13	Operator, Organizational Direct support Maintenance Manual, Fuel System, Supply Point, Six Fuel and Oil Servicing Nozzles, 60,000-gallon Capacity; with Two Pumps; Two Filter/separators; Six Loading Standards; and Six Collapsible Fabric Tanks (FSN 4930-542-2518).

PROGRAMED REVIEW

SOLUTIONS

Exercise	Solution
A1	to, from
A2	filter elements
A3	filter/separator
A4	front
A5	allows for product expansion
A6	issue
A7	depots
A8	fairly level ground, area large enough to use all hose, natural cover
A9	receiving, dispensing
A10	volume
A11	surface
A12	top
A13	petroleum gage
A14	dome, shell

41

LESSON 2 **Credit Hours: 2**

LESSON ASSIGNMENT

SUBJECT Quality Surveillance and Petroleum Testing Facilities.

STUDY ASSIGNMENT Lesson Text.

SCOPE Categories of petroleum products; use of military and Federal specifications; importance of and responsibility for the POL quality surveillance program; indications, causes, and disposition of off-specification products; and Army petroleum laboratories and equipment.

OBJECTIVES As a result of successful completion of this assignment, you will be able to--

1. Identify petroleum products by use of military and Federal specifications.
2. Identify the four main categories of petroleum products used by the US Army.
3. Differentiate between on-specification and off-specification petroleum products and identify two major causes of off-specification products.
4. Differentiate between the procurement inspection and quality surveillance programs for petroleum products.
5. Identify three major causes of contamination of petroleum products.
6. Describe the three CONUS petroleum quality surveillance programs.
7. Identify the service and office that share responsibility for overseas quality surveillance of petroleum products.
8. Describe the primary methods of disposing of off-specification petroleum products.
9. Locate the U.S. Army General Materiel and Petroleum Activity (USAGMPA) two testing laboratories in CONUS and identify the services furnished.

ILLUSTRATIONS

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3	Primary grades of burner fuels and principal uses	41
4	SAE and Military Symbol Equivalents	42
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LESSON TEXT

1. GENERAL. It is estimated that 60 percent of the supplies entering a theater of operations will be petroleum products. The career Army officer, especially the Quartermaster officer, should be familiar with petroleum products. He should be able to recognize the main types or product categories by their physical appearance; and, through the use of applicable military and Federal specifications, he should be able to recognize their chemical and functional properties. In addition, he should be familiar with the Army's quality surveillance program. The purpose of this program is to make sure that users receive only clean, usable petroleum products. The career officer may serve as the S4/G4 of a combat arms unit where he will be expected to know the condition of petroleum, oils, and lubricants (POL) his unit receives. The condition of POL products is important; if they are contaminated during handling, transporting, or storing they are no longer suitable for their intended use. If such contamination is not detected and the product is used, it can cause engine damage or failure which could result in danger to personnel or damage to equipment. Therefore, it is essential that the quality of petroleum products be maintained in order to safeguard personnel and equipment. Everyone who physically handles petroleum products shares in the responsibility for quality surveillance.

2. USE OF FEDERAL AND MILITARY SPECIFICATIONS. Specifications are procurement documents which are widely used by the Government to establish requirements in terms of a product's design detail or performance, or both. A specification may cover a single item or thousands of items in a single style or type. Federal specifications are used by all Federal agencies. Military specifications are issued by military agencies and are used for the procurement of military supplies, equipment, or services.

a. IDENTIFYING NUMBER. The numbering system used to identify specifications is in three parts:

(1) PART 1. A combination of letters which designate the agency responsible for issuing the specification. Some examples are furnished below:

MIL: Military Specification
JAN: Joint Army-Navy Specification
MPD: Military Petroleum Development
TT, P, PP, VV: Federal Specifications

(2) PART 2. The second part of the number consists of a single letter, representing the first letter of the nomenclature of the product as listed in the title of the specification. For example:

K–Kerosene	G–Gasoline or Grease
F–Fuel	C–Compound
T–Jet Fuel	L–Lubricants

(3) PART 3. The third part consists of a number, usually of two or more digits, followed in some instances by another letter or number indicating a revision

or amendment. It is a serial number for any given letter group and aids in identifying the product. For example:

MIL-L-15018A (Lubricating Oil–one revision).
MIL-L-15012B-AM 1 (Lube Oil–revised twice and amended once).
VV-F-815C (Fuel Oil–revised three times).

b. FORMAT. The standard format for both Federal and military specifications includes six sections.

(1) Section 1 has a heading which gives the identification, date, and title of the specification. This section includes a scope which outlines the coverage of the specification, and a classification if applicable, which lists the type, grade, or class of materials or product.

(2) Section 2 lists applicable documents and references.

(3) Section 3 covers requirements and descriptions referring to the character and quality of materials and product characteristics.

(4) Section 4 covers the quality assurance provisions, including tests and examinations made.

(5) Section 5 covers preparation for delivery, including preservation, packaging, packing, and marking.

(6) Section 6 includes notes and concluding information, such as intended use, ordering data, and qualification. The identity of the preparing activity and the project number are also shown.

c. REVISION OR AMENDMENT. A specification revision is generally concerned with the deletion or rewording of material. An amendment is generally concerned with the inclusion or deletion of material.

3. CATEGORIES OF PETROLEUM PRODUCTS BY FUNCTIONAL USE. The five basic categories of petroleum products used by the military are automotive, aviation, burner fuels, lubricants, and specialty items.

a. GASOLINE, JET, AND DIESEL FUELS. Automotive and aviation gasolines contain the same components but differ in boiling range. Jet fuel is a kerosene-based fuel with a relatively high boiling range. Diesel fuels are distilled from a petroleum base and have a different flashpoint and boiling range from the other fuels.

(1) AUTOMOTIVE GASOLINE. Automotive gasolines have components with a boiling range of 90° F to 420° F. The components in automotive gasoline do not have to be controlled within the narrow limits set for aviation gasoline. In automotive gasolines, more of the valuable aromatics can be used and more alkalines

are acceptable than in aviation gasolines because storage requirements are not as strict. Commercial automotive gasoline is supplied under Federal specification VV-G-76C, and combat automotive gasoline is supplied under Military specification MIL-G-3056C. Table 1 shows the requirements for combat automotive gasoline. Properties of selected fuel components are shown in table 2.

Table 1. Requirements for Combat Automotive Gasoline, MIL-G-3056C

Requirements		[1]Type I	[2]Type II
Distillation:			
10 percent evaporated	°F	131-158	[3]122
50 percent evaporated	°F	194-239	150-203
90 percent evaporated	°F	293-356	[3]302
Residue	percent	2.0	2.0
Reid vapor pressure	psi	7-9	12-14
Octane number (min):			
Motor method		86	86
Research method		95	95
Gum, mg./100 ml. (max)		4.0	4.0
Sulfur (max)	percent	0.15	0.15
Corrosiveness @ 122° F (max)		1	1
Antiknock compounds:			
Total lead content, g/gal		3.17	3.17
Oxidation stability (min)	min	480	480
Color		Red	Red

[1]For general use at all temperatures above 0° F.
[2]For use in areas where the mean temperature is consistently below 32° F.
[3]Maximum.

Table 2. *Properties of Selected Fuel Components*
(From Aviation Fuels (NAVAER 00-A-001), Shell Corp.)

Component	Properties									
	Carbon	Hydrogen	Boiling pt	Reid Vapor Pressure (RVP)	Freezing pt	1 Heating value	2 Performance numbers			
							No Lead		Lead 4 ml.	
							Lean	Rich	Lean	Rich
Paraffins:	Percent	Percent	°F		°F	Btu's/lb				
n-Pentane	83.2	16.8	97		-201	19,300	61	61	63	63
2-Methylbutane (Isopentane)	83.2	16.8	83		-256	19,300	74	---	120	130
2, 2-Dimethylbutane (Neohexane)	83.6	16.4	122	10	-148	19,200	78	---	130	130
2, 3-Dimethylbutane	83.6	16.4	136	8	-199	19,200	85	---	140	160+
n-Heptane	83.9	16.1	209	1.7	-131	19,200	0 [3]	0 [3]	50	50
2, 4-Dimethylpentane	83.9	16.1	177	3.5	-183	19,100	62	62	95	95
2, 2, 3-Trimethylbutane (Triptane)	83.9	16.1	178	3.5	- 13	19,100	140	200	200	300
2, 2, 4-Trimethylpentane (Isooctane)	84.1	15.9	211	1.8	-161	19,100	100	100	153	153
2, 2, 3-Trimethylpentane	84.1	15.9	230	1.2	-170	19,100	100	120	150	160+
2, 3, 3-Trimethylpentane	84.1	15.9	239	0.9	-149	19,100	100	120	150	160+
2, 3, 4-Trimethylpentane	84.1	15.9	236	1.0	-165	19,100	100	120	150	160+
Naphthenes:										
Cyclopentane	85.6	14.4	121	10.5	-137	18,800	65	100+	100	160+
Methylcyclopentane	85.6	14.4	161	4.8	-224	18,800	58	---	88	140
Cyclohexane	85.6	14.4	177	3.3	44	18,700	55	---	84	130
Aromatics:										
Benzene	92.3	7.7	176	3.2	42	17,300	68	160+	68	160+
Toluene	91.2	8.8	231	1.2	-139	17,400	93	160+	95	160+
1, 2-Dimethylbenzene (Ortho-xylene)	90.5	9.5	292	0.3	- 13	17,500	85	85	100	100
1, 3-Dimethylbenzene (Meta-xylene, Para-xylene)	90.5	9.5	282	0.35	- 54	17,500	100	160+	100+	160+
1, 4-Dimethylbenzene (Meta-xylene, Para-xylene)	90.5	9.5	281	0.35	56	17,500	100	160+	100+	160+
Ethylbenzene	90.5	9.5	277	0.4	-139	17,600	93	160+	100	160+
Cumene (Isopropylbenzene)	89.9	10.1	306	0.3	-141	17,700	78	160+	93	160+
n-Propylbenzene	89.9	10.1	319	0.15	-147	17,700	78	160+	93	160+
Olefins:										
2-Methylpropene (Isobutylene)	85.6	14.4	20	65	-321	19,400				
2, 3, 3-Trimethyl-1-butene (Triptene)	85.6	14.4	172	3.6	-169	19,100	75	---	84	
2, 4, 4-Trimethyl-1-pentene (Diisobutylene)	85.6	14.4	215	1.6	-136	19,000	64	---	85	160+
2, 4, 4-Trimethyl-2-pentene	85.6	14.4	221	1.4	-160	19,000	64	---	85	160+

[1] Net or lower.
[2] Approximate values
[3] Octane numbers.

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(2) AVIATION GASOLINE. Aviation gasolines are mixtures of hydrocarbons that boil at temperatures in the approximate 80° to 340° F range. They have a gravity range of 60° to 75° F American Petroleum Institute (API) scale. Producing a satisfactory fuel for aircraft and all gasoline-engine-driven piston engines is mostly a matter of blending and controlling the proportions of various hydrocarbons; sometimes the process involves altering the structures of the hydrocarbons. The only aviation gasoline procured for military use is grade 100/130. This is the only fuel procured for military use that is colored blue for ease of identification.

(3) JET OR TURBINE FUELS. Jet fuel of the gasoline-type is a mixture that boils at 120° to 500° F. Most manufacturers of jet aircraft prefer a kerosene-type fuel; this is a mixture of hydrocarbons that boils in the approximate 400° to 600° F range. Gravity varies from a low of 48° API to a high of 57° API. The use of a kerosene-type fuel eliminates vapor lock, slugging (carrying away of fuel in the vapor streams from the vents), loss of light ends, and icing due to evaporation; also, it provides greater heat energy per pound, increases safety (in flight and on the ground), and does not ignite as quickly in case of a crash. A primary consideration in the development of any petroleum fuel is its availability in relation to other fuels. Generally, gasoline producers can produce more gasoline than jet or turbine fuel because a barrel of crude oil contains approximately twice as much materiel in the gasoline range as in the jet-diesel fuel range. Jet fuels for turbine engines are procured under specification MIL-T-5624; jet fuels for supersonic aircraft are procured under specification MIL-F-25656.

(4) DIESEL FUELS. Diesel fuels are procured for both land and marine uses. Land-use fuels are procured under specification VV-F-800: DFA-Arctic for use in high-speed diesel engines at temperatures lower than 25° F; DF1 for winter use in high-speed diesel engines where temperatures are 25° F or higher; and DF2 for use in high- and medium-speed automotive diesel engines where the temperature is above 20° F. Marine diesel fuel is procured under MIL-F-16884G for use in submarine engines and shipboard diesel engines.

b. BURNER FUELS. Burner fuels are used under boilers or in furnaces to generate power or heat. Specifications for these fuels are not exacting; however, even though they may be procured on a worldwide basis, the fuels must be compatible. This is important because some burner fuels, stable when stored separately, may not be stable when combined. Liquid fuels have many advantages over solid fuels. They have a greater value on a weight or volume basis, require less storage space, and are easier to handle and fire. Liquid fuels also produce more efficient combustion because of better contact between fuel and air and because of the almost complete absence of ash; therefore, they produce a greater heat input for a given combustion space.

(1) APPLICATION. Fuel oil is fed to the furnace or boiler continuously and at a uniform rate, and it is vaporized (turned into vapor) or atomized (turned into fine droplets) for necessary contact with air for efficient combustion. Auxiliary equipment includes storage tanks, preheaters for use if the fuel is high in wax content or is too viscous for easy handling at the usual temperatures, strainers to remove sediment, pumps to supply the fuel to burners under pressure, and blowers for forced draft.

(2) REQUIREMENTS. Burner fuel is supplied under specification MIL-F-859 in grade Navy Special for steam-powered Navy vessels and for other steam-powered Government-service vessels. Burner fuel is supplied under specification VV-F-815C for general heating purposes in grades FO No. 1, 2, 4, 5(heavy) and 6. These fuel oils differ in viscosity (the ability of a liquid to retain the shape and arrangement of its elements during flow), gravity, and in the types of burners they require. Some fuels require preheating before combustion takes place, and they are used in burners that have preheaters. The primary grades of burner fuels and their principal uses are shown in table 3.

Table 3. Primary grades of burner fuels and principal uses

Grade	Type	Use
OF-1	Burned by vaporization	Light domestic heating (homes)
OF-2	Burned by vaporization and atomization	General-purpose domestic heating (barracks)
OF-4	Not heated	Semi-industrial (schools, department stores, and similar facilities)
OF-5	Preheated, low viscosity	Semi-industrial (used in burners equipped with preheaters)
OF-6	Preheated, high viscosity	Industrial plant (used in burners equipped with preheaters)

c. LUBRICANTS. This class of petroleum products is most often used by the military.

(1) LUBRICATING OILS. Lubricating oils used by the military are too numberous to list; however, three important categories--military symbol oils, crankcase oils, and gear oils--account for a great volume of such products. The Federal Supply Catalog Identification List (C9100-IL) (now on microfiche) contains a complete list of petroleum products and specifications. Most lubricating oils procured for the military are identified by a 4-digit number. The first digit indicates the class of the oil, and the last three digits indicate the approximate viscosity. For example, the symbol 9250 would indicate the following:

9	250
Class: heavy-duty internal combustion engine oil	viscosity (resistance to flow)

The Society of Automotive Engineers (SAE) classifies motor oils by numbers according to their viscosity. Such terms as SAE and OE are used synonymously. Lubricating oils distillate stocks contain substances in the approximate C_{20} to C_{50} range; these oils boil in the approximate range of 700° F to 1,000° F. After being refined to remove most of the undesirable components such as wax, asphalt, and oxidizable impurities, the stocks are blended and compounded with fatty materials, and additives are blended in. The additives delay oxidation and the formation of acids; suppress crystallization of wax, thereby lowering the pour point; promote oiliness; strengthen the lubricating film; reduce foaming; improve the viscosity index; and supply a detergent and dispersant quality. Table 4 below compares SAE numbers and equivalent military symbol oils.

Table 4. SAE and Military Symbol Equivalents

SAE NUMBER	MILITARY SYMBOL OILS
10W	2110, 2110H
20W	2110, 2110H, 2075, 3050, 9110
20	2135, 2135H, 3050
30	2190, 2190TEP, 8190, 9250
50	7105
70	5150, 6135
80	3065, 9170
90	3080, 3100, 9370, 9500
140	3120, 5150, 5190
250	5230

(2) LUBRICATING GREASES. These are blends of lubricating oils, soaps, and other bases for thickening, and any of the additives used in the base oils. These greases are used on gear trains or chain drives that do not retain oils; on equipment that is dirty, dusty, or wet, and on which an effective seal against foreign matter is needed; on inaccessible bearings; and in food processing plants and paper and textile mills where drip and spatter must be avoided. Greases are classified according to their soap bases or thickeners. The soaps are derived from fatty animal or vegetable oils. The newer greases include a disperser of soap in nonpetroleum liquids and a nonsoap thickener in petroleum oils. A third type, nonpetroleum-nonsoap, consists of such substances as silicone liquids thickened with alkyl ureas. General classes of lubricating greases are shown in table 5. Some of the greases the Army uses in large volume are general-purpose industrial grease, supplied under Federal specification VV-G-632; automotive and artillery grease, supplied under specification MIL-G-10924C(1); and ball and roller bearing grease, supplied under specification MIL-G-18709A(3).

Table 5. General classes of greases

Type	Characteristics	Use
Calcium base	Water resistant Do not retain consistency at high temperatures	In relatively slow-moving bearing
Sodium base	Soluble in water Hold up well in high temperatures	In gears and faster-moving bearings
Lithium base	Water resistant Good low temperature characteristics	Often restricted to low-volume application
Aluminum base	Water resistant Retain consistency well at moderate temperatures	Gears, reciprocating parts, lubrication of equipment used in food and textile mills
Barium base	Water resistant Can be used at high temperatures	
Mixed base	Used where calcium or sodium-based greases cannot be used	High-speed, antifriction bearings, lubrication of steamheated calender rolls in paper and textile mills

d. SPECIALTY ITEMS. There are many products that are petroleum-based but are not covered by the first three principal classes of products. Chief among these is Stoddard drycleaning solvent, procured under specification P-S-661 and used for drycleaning and for cleaning machinery and tools. Other specialty items include a variety of petroleum-based products which range from hydraulic fluids, fog oil, and cutting and insulating oils, to ski wax.

4. QUALIFICATION TESTING AND ACCEPTANCE OF PETROLEUM PRODUCTS. Before a petroleum producer can submit his product for purchase by the military, the product must qualify for placement on the qualified products list (QPL). This indicates his product meets grade and type specification requirements. The QPL lists the name and plant address of the manufacturer and distributor and the product

identification and test reference. Qualification is the entire process by which petroleum products are solicited from manufacturers and distributors and examined and tested. In the continental United States (CONUS), primary responsibility for examining and testing petroleum products is assigned to the Defense Contract Administration Services (DCAS). In overseas areas, procurement quality assurance acceptance is performed by quality assurance representatives operating under the technical and administrative control of the Defense Fuel Supply Center, and military services provide them administrative support and laboratory testing facilities on request.

a. FOB ORIGIN CONTRACTS. Inspection is usually made at origin to determine compliance with all terms of the contract. When products are also accepted at origin, inspection at destination is limited to identifying the product and determining the quantity and condition of the container or packaging.

b. FOB DESTINATION CONTRACTS. Under this type of contract, title to the product passes to the Government at point of delivery, and the product is inspected by the receiving activity at time of delivery. Regional bulletin contracts covering motor gasoline, diesel fuel, burner fuels, and the like are inspected at destination.

c. LABORATORY FACILITY SUPPORT. Each military service must maintain laboratory facilities in CONUS to test samples of petroleum products submitted by quality assurance representatives for testing purposes. Qualification testing insures uniformity of products to meet established standards and insures that each company's products will be compatible with those of other manufacturers so that the mixing of products from various firms will not result in damage to the equipment used.

d. MILITARY DEPARTMENT TECHNICAL QUALITY OFFICES. Any deviation in contract specifications must be approved by the Technical Quality Office of the applicable military department. The Technical Quality Office of the Army is located at the US Army General Materiel and Petroleum Activity, New Cumberland Army Depot, New Cumberland, PA.

PROGRAMED REVIEW A

The questions in this programed review give you a chance to see how well you have learned the material in paragraphs 1-4.

Read each item and write your answer on the line or lines provided for it. Please use a pencil to write your answers. If you do not know, or are not sure, what the answer is, check the paragraph reference that is shown in parentheses right after the item; then go back and study or read once again all of the referenced material and write your answer.

After you have answered all of the items, check your answers with the Solution Sheet at the end of this lesson. If you did not give the right answer to an item, erase it and write the correct solution in the space instead. Then, as a final check, go back and restudy the lesson reference once more to make sure that your answer is the right one.

A1. In the Federal specification VV-F-800, what part of the specification number identifies the product as a fuel? _____ _____. (para 2a(2))

A2. In the specification MIL-G-3056C, the MIL stands for _____ _____ and the 3056 is a _____ _____ for identifying the product. (para 2a(1) and (3))

A3. One of the categories of petroleum products used by the US Army includes _____ and _____ gasolines. (para 3a(1)(2))

A4. Jet fuel, which is used by the US Army, may be either of _____ or _____ types. (para 3a(3))

A5. The five categories of petroleum products used by the military are automotive and aviation, specialty items; and _____ _____. (para 3)

A6. Lubricants represent one category of petroleum products used by the US Army. In engine oil the _____ rating and the _____ are identical. (para 3c(1))

A7. Specialty items is one of the major categories of petroleum products used by the Army. The most important specialty items are _____ _____

A8. One requirement of qualification testing is that before a petroleum producer can submit his product for purchase by the military, the product must qualify for placement on the _____ _____ _____. (para 4)

A9. Qualification is the entire process by which petroleum products are solicited from manufacturers and distributors and are then _____ and _____. (para 4)

A10. Under the requirements of procurement inspection, petroleum products are inspected for contract compliance at _____. (para 4a)

DO YOU UNDERSTAND EVERYTHING IN THIS PROGRAMED REVIEW? HAVE YOU CHECKED YOUR RESPONSES, MADE CORRECTIONS, AND RESTUDIED THE TEXT, IF NECESSARY: IF YOU HAVE, GO ON TO THE NEXT STUDY UNIT OF THIS SUBCOURSE.

5. QUALITY SURVEILLANCE IN CONUS. The General Materiel and Petroleum Activity, New Cumberland Army Depot, Pennsylvania, under the staff supervision of Headquarters, US Army General Materiel and Petroleum Activity (USAGMPA) is responsible for developing and monitoring quality surveillance and technical programs for Army-owned petroleum products. The programs are conducted by petroleum representatives of two worldwide depots. New Cumberland Army Depot, New Cumberland, PA, has responsibility for the Eastern area which is bounded by the Canadian border and extends southward along a line following the western borders of Minnesota, Iowa, Missouri, Arkansas, and Louisiana. The Sharpe Army Depot, Lathrop, CA, has responsibility for the geographical area west of the Eastern area. The Army has two quality surveillance programs that are operational and a third program for furnishing technical advice to installations and other activities.

a. QUALITY SURVEILLANCE PROGRAMS. There are three basic objectives of the quality surveillance programs conducted by the Army. They are to maintain on-specification product standard, to detect off-specification petroleum products, and to recommend appropriate reclamation or disposition instructions for off-specification products. A product is considered to be off-specification when it fails to meet the quality standards established by the specification. It is on-specification when it meets specification requirements. There are two programs conducted in CONUS.

(1) INSTALLATION PROGRAM. The installation program for quality surveillance applies to all petroleum supplied by commercial sources under regional-type contracts, to petroleum procured locally, or to that received from Army or Defense Logistics Agency (DLA) depot stocks. The program provides for laboratory testing of samples of petroleum products. The representative of the petroleum division of the appropriate depot arranges for installations to submit samples to the appropriate depot laboratory. When the samples are tested, the installations are notified of the results.

(2) STORAGE QUALITY SURVEILLANCE PROGRAM. This program includes DLA, storage, Army storage, and commercial storage of petroleum products. DLA-owned and Army-owned packaged petroleum products and containers at the same DLA location are not segregated. The products are issued on a first-in, first-out basis, and DLA quality surveillance procedures are followed. The US Army Petroleum Center (USAPC) established quality surveillance procedures for petroleum products and containers at other than DLA locations. When inspection reveals products that are off-specification to the extent that their use could endanger personnel or damage equipment, the petroleum representative, with the approval of the depot commander, may place freeze orders on Army stocks. Except for specified products that require less frequent inspections, products in Army and other military storage and in commercial terminals must be inspected monthly. A representative of the Defense Contract Administration Services (DCAS) inspects petroleum products at commercial terminals; at Army storage activities, a military representative at the storage location inspects and samples the products.

b. TECHNICAL ADVISORY PROGRAM. The main purpose of the technical advisory program is to help commanders determine whether petroleum products and handling facilities are managed according to instructions. The program is also intended

to provide a supply and technical advisory channel through which commanders can resolve petroleum problems. The petroleum representative coordinates with the Army Commanders, Military District of Washington, US Army; US Army Air Defense Command, State National Guard adjutant generals and Army Reserve commanders, as necessary, in establishing schedules and coordinating advisory visits. A report of each visit is made to the appropriate command; when visits disclose unsatisfactory conditions, the Army, National Guard, and Army Reserve are responsible for directing that corrections be made. Visits to certain activities are made automatically. Other installations are visited only by request, and when it is decided that an advisory visit is needed, samples are shipped to the designated petroleum laboratory.

c. OPERATIONAL SURVEILLANCE REQUIREMENTS. A general discussion of some of the requirements is given below.

(1) FILTER/SEPARATORS. The filter/separators on all equipment used to refuel aircraft must be checked every 30 days by taking samples from the effluent stream and having the samples tested at a petroleum laboratory. If tests prove that the product is unsatisfactory, the submitting activity is advised to change the filter/separator elements.

(2) PETROLEUM PRODUCTS DRAINED FROM VEHICLES, AIRCRAFT, AND ENGINES. These must be segregated to prevent possible use of deteriorated or contaminated products. The only exception is small amounts of fuel removed from aircraft to obtain proper weight and balance; this fuel is returned directly to the storage tank or the field servicing truck. Lubricating oils drained from vehicles, aircraft, or engines must be turned over to the property disposal officer for salvage disposition. Drainage of less than 1,000 gallons of gasoline accumulated in 60 days or more is turned over to the property disposal officer for salvage disposal. An amount less than 1,000 gallons of a particular grade of aviation gasoline may be blended off in motor gasoline tanks at a 1 to 3 ratio. When 1,000 or more gallons accumulate in a single tank, samples are sent to a laboratory for testing. If test results are within specification limits, the depot furnishes disposition instructions; if test results exceed limitations, the depot forwards the case to the General Materiel and Petroleum Activity, New Cumberland Army Depot for disposition instruction.

(3) GASOLINE IN STORAGE. Stocks of motor and aviation gasoline are usually consumed in a relatively short time by CONUS activities; however, the unstable character of gasoline makes it necessary to take precautions to prevent damage to equipment. Motor and aviation gasoline in aboveground storage for 30 days without the addition of fresh stocks should be tested monthly in areas where the prevailing temperature is 90° or higher. At lower temperatures, gasoline stored in either aboveground or underground storage tanks should be tested at the end of any 90-day period in which no fresh stock was added.

6. QUALITY SURVEILLANCE AND PETROLEUM LABORATORY FACILITIES OVERSEAS. The military department having physical possession of the petroleum product is responsible for quality surveillance and for the maintenance and operation of laboratories for testing. The Joint Petroleum Office (JPO) serves as area coordinator and insures that an adequate quality surveillance program is maintained within the unified command. Each military department with forces overseas is therefore assigned responsibility for maintaining and operating petroleum laboratories in specific areas. For example, the US Army has the responsibility for maintaining laboratories in Alaska, Germany, Korea, and the Ryukyus Islands. As a rule, one laboratory in each specific area is equipped for quality acceptance testing.

a. ESTABLISHING NEW LABORATORIES. When additional laboratories are required by the expansion of US interests beyond the operations established as of 20 September 1966, the unified commander concerned will determine which department should provide the needed laboratory and will forward the findings to the departmental headquarters concerned. After review of the proposal as related to overall staffing, budget, and planning considerations, the headquarters will establish a fully coordinated position and will advise the commander accordingly.

b. CLOSING EXISTING LABORATORIES. Established laboratories in overseas areas may be closed at any time the unified commander determines they are no longer needed by the unified command. However, a department maintaining a laboratory may retain it, even if the commander has recommended it be closed, if the department needs it to support department operations. The transfer of a laboratory from one department to another should be avoided.

7. CAUSES OF OFF-SPECIFICATION IN PETROLEUM PRODUCTS. Deterioration, contamination, or microbiological growth may cause off-specification of petroleum products; therefore, tests for each of these is important. Aviation gasoline requires more exacting tests. Most of the tests described in the following paragraphs apply to aviation gasoline. Automotive gasoline tests are listed in table 6.

a. DETERIORATION. A product is considered to have deteriorated when one or more of its characteristics have changed to such an extent that the quality of the product is no longer within the deterioration use-limits of the product specification. Deterioration is brought about by age, and unfavorable storage conditions may speed up deterioration. The most common forms of deterioration are evaporation, gum formation, and loss of additives.

(1) EVAPORATION. This is the loss of volatile (rapidly evaporating) components through vaporization. Volatile components make engines start more easily; if these components evaporate, engines are difficult to start, especially in cold temperatures. The effects of evaporation are most noticeable in aviation and motor gasolines.

(2) GUM FORMATION. Gum formation is the most troublesome and the most common form of deterioration in internal combustion engine fuels. Unsaturated hydrocarbons in fuels tend to undergo chemical changes in the presence of oxygen, producing gummy materials first and resinous materials later. Although the gummy materials are dissolved in the fuel, they are difficult to vaporize and may form deposits

TABLE 6. Types of Tests Required on Gasoline, Automotive

CHARACTERISTICS	TYPE B-1 TEST	TYPE B-2 TEST	TYPE B-3 TEST	TYPE C TEST
Appearance	X	X	X	X
Water and Solids (Visual)	X	X	X	X
Color (Visual)	X	X	X	X
Specific or API Gravity	X	X	X	X
Distillation	X	X	X	–
Reid Vapor Pressure	X	X	–	–
Copper Strip Corrosion	–	X	X	–
Unwashed Gum	–	X	X(1)	–
Knock Rating	X(2)	X	–(2)	–
Oxidation Stability	–	X	–	–
Lead Content	–	–	X	–

(1) Unwashed gum, without solvent wash, shall not increase by more than 2 mg as compared to the original product. In the event of gum increase exceeding 2 mg. a type A test, as defined in the legend, will be run.

(2) In the case of pipeline, this shall be done when considered necessary.

in the fuel lines, clog carburetor jets during vaporization of the fuel, or form sticky deposits on the piston rings or valves of an engine. The resinous materials which form do not dissolve in the fuel but slowly settle on the walls and bottoms of the containers. The gum or oxidation inhibitors that are added to these fuels are effective for only a short time and do not offer permanent protection.

(3) LOSS OF ADDITIVES. Additives are compounds that are blended into petroleum products either to improve the product's properties or to give the product new properties. For example, various compounds are added to lubricating oils to inhibit corrosion, to lower the pour point, to enable the oil to withstand extreme pressure, to prevent foaming, or for other purposes. Additives may lose effectiveness during prolonged or improper storage.

b. CONTAMINATION. Clean fuels are essential for the proper performance and maximum efficiency of equipment in which they are used. Both the military and industry devote a great deal of effort toward the development of handling and surveillance procedures, equipment, and devices to insure the delivery of clean aviation fuels. Fuel cleanliness requirements are much stricter for jet fuel than for fuel for piston engines. High-pressure, complex metering equipment is built to close tolerance to provide precise metering over a wide range of altitude, speed, and power; therefore, dirt and water contamination is more critical in such equipment. Because of high consumption rates, contamination accumulates more rapidly. Fine contaminants may block engine fuel supply systems; and these fine contaminants may gradually eat into critical parts of the engine and the fuel control system. Free water freezing (table 7) at high altitudes may plug screens and cause engine flameout. Salt water, especially, will cause fuel system corrosion. Aircraft engines are not designed to remove fine contaminants or excessive amounts of contaminants; therefore, fuel cleanup must be accomplished on the ground. Fuel contamination can be divided into two general classifications: contamination with other petroleum products and contamination with water and solids.

(1) CONTAMINATION WITH OTHER PETROLEUM PRODUCTS. This type of contamination usually results from accidental mixture during transportation and storage. It is detected through laboratory tests varying from a simple gravity test to a knock-rating test in a laboratory engine. These tests are usually conducted at petroleum testing laboratories.

(2) CONTAMINATION WITH WATER AND SOLIDS. Contamination with free water and solids is usually clearly visible because free water and solids cannot mix with fuel. Free water accumulation in aviation fuel causes icing of fuel systems and erratic gage readings. Large amounts of water can cause flame out. Table 7 gives a detailed breakdown of some of the forms of water and solids contaminations that occur most frequently. The solid contaminants consist of both sediment and microbiological growth (suspended particles).

Table 7. Contaminants in fuels

Contaminant	Appearance	Characteristics	Effects on aircraft
Water:			
Dissolved water	Not visible.	Fresh water only; separates as cloud when fuel cools.	None, as long as it remains in solution; see free water.
Free water	Light or heavy cloud; droplets clinging to sides of container; or large amounts on bottom of container.	Fresh water or salt water.	Icing of fuel system, erratic gage readings; large amounts can cause flameout; salt water corrodes fuel system components.
Solid matter:			
Rust	Red or black powder, rouge, or grains; may appear as dye-like material in fuel.	Red (Fe_2O_3) nonmagnetic; black (Fe_3O_4) magnetic; often comprises 70-90 percent of total solids.	Causes sticking, sluggish or general malfunction of fuel controls, flow dividers, pumps, nozzles, and other equipment.
Sand or dust	Crystalline, granular, or glass-like.	Often comprises 0-20 percent of total solids.	Same as rust.
Aluminum, cadmium or magnesium.	White or gray powder or paste.	Sometimes sticky or gelatinous when wet; sometimes comprises 0-10 percent of total solids.	Same as rust; and may reduce flight range and high altitude performance.
Emulsions:			
Water in fuel	Light or heavy cloud.	Finely divided drops of water in fuel; same as free water cloud; usually settles out at about the same rate as free water.	Same as free water.
Fuel in water	Reddish, grayish, or blackish; sticky material variously described as gelatinous or gummy; often appears as fibrous or stringy material in clear or cloudy fuel.	Finely divided drops of fuel in water; often contains rust that stabilizes the emulsion; adhers to materials normally in contact with fuel; emulsion may persist for indefinite period; contains 30-70 percent water, and 30-50 percent fuel.	Same as free water and sediment of suspended matter; quickly causes filter plugging and erratic readings in fuel quantity probes.
Miscellaneous:			
Interfacial matter	Lacy bubbles or scum in interface; resembles jellyfish.	Result of bacterial action on surface in fresh water; H_2S may be generated.	Same as free water; deposits of matter may be left in fuel tanks.
Air bubbles	Cloud in fuel.	Easily dissipated.	None.

c. MICROBIOLOGICAL GROWTH. This consists of living organisms; it is usually found wherever there are pockets of water in fuel tanks. These organisms include protozoa, fungus, and bacteria; of these, fungus causes most of the problems associated with contamination of jet fuels. Fungus is a form of vegetable life that holds rust and water in suspension; it is an effective stabilizing agent for fuel-water emulsion. Fungus clings to glass and metal surfaces, and it can cause erroneous readings in fuel quantity systems, sluggish fuel control operation, and sticking fuel dividers. Microbiological growth is brown, black, or gray in color; it appears as a stringy, fibrous substance.

8. DISPOSITION OF OFF-SPECIFICATION PETROLEUM PRODUCTS. When laboratory tests indicate a petroleum product is off-specification, the cause is identified and the product is disposed of. There are several methods of disposition. The product may be used for its intended purpose, downgraded and used for a purpose different from the one for which it was intended, blended with on-specification fuel, re-refined (if economical), or turned over to property disposal personnel for sale or disposal by burning. The military department that has custody of the product decides whether contaminated fuel should be reclaimed or salvaged. This decision is based on availability of materials, time, equipment and necessary labor.

a. USING PRODUCT FOR ITS INTENDED PURPOSE. Products which reach the field do not necessarily have to meet specifications. MIL-HDBK-200E prescribes the allowable use limits; these are the allowable limits to which the properties of a product can deteriorate before it must be downgraded or declared unusable for its original intended purpose. The chief technician may recommend off-specification products within allowable use limits be used for their intended purpose. This recommendation may specify a time limit on the use of such products.

b. DOWNGRADING. In some cases a product that is off-specification or only slightly contaminated may be downgraded; this means it is approved for use as a lower grade of the same or a similar product. For example, if aviation fuel meets all specifications except performance number or octane number, it may be downgraded and used as a lower grade of aviation fuel or as a higher grade of automotive fuel. If combat motor fuel meets all requirements except the octane rating, it may be downgraded for use as a lower grade of motor fuel. Diesel fuel that is slightly contaminated may be downgraded and used as fuel oil.

c. BLENDING. Sometimes it is possible to mix two or more similar petroleum products to produce a product of intermediate grade or quality. This process is called blending. The petroleum laboratory must determine what proportions of each product must be blended to obtain the desired result; also, the petroleum laboratory performs certain tests on the blend to insure that it meets the product specificiations.

d. SELLING OR DESTROYING. If tests indicate that an off-specification product cannot be reclaimed, it is turned in to Property Disposal.

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PROGRAMED REVIEW B

The questions in this programed review give you a chance to see how well you have learned the material in paragraphs 5-8.

Read each item and write your answer on the line or lines provided for it. Please use a pencil to write your answers. If you do not know, or are not sure, what the answer is, check the paragraph reference that is shown in parentheses right after the item; then go back and study or read once again all of the referenced material and write your answer.

After you have answered all of the items, check your answers with the Solution Sheet at the end of this lesson. If you did not give the right answer to an item, erase it and write the correct solution in the space instead. Then, as a final check, go back and restudy the lesson reference once more to make sure that your answer is the right one.

B1. The installation quality surveillance program permits installations to submit _____ _____ for testing and to receive notification of the test results. (para 5a(1))

B2. Under the Storage Qualification Program, when inspection at Army depots indicates that product deterioration could endanger personnel or damage equipment, when the depot commander approves, a _____ _____ may be placed on Army petroleum stocks. (para 5a(2))

B3. The Technical Advisory Program provides commanders with a channel through which they can resolve _____ _____. (para 5b)

B4. The USAGMPA testing laboratories for the Eastern United States is located at the _____ _____ _____ Depot. (para 5)

B5. The USAGMPA petroleum testing laboratory for the Western United States is located at the _____ _____ Depot. (para 5)

B6. The quality surveillance program in CONUS has three objectives: to maintain product standard, to detect off-specification products, and to recommend _____ _____ or _____ of contaminated products. (para 5a)

B7. Petroleum laboratories overseas have special areas assigned and are maintained by each _____ _____. (para 6)

B8. An adequate overseas quality surveillance progam within unified commands is the responsibility of the _____ _____ _____. (para 6)

B9. Causes of off-specification in petroleum products include microbiological growth, _____, and _____. (para 7a, b)

B10. What are the two major causes of fuel contamination? _____ _____ _____ (para 7b(1) and (2))

B11. When petroleum products have characteristics changed to the extent that the quality is no longer within the product use-limits, the product is said to be _____ _____. (para 5a)

B12. Primary methods of disposing of off-specification petroleum products are _____, _____, or turning product in for _____. (para 8)

B13. Aviation gasoline that is off-specification may be _____ and used as _____ fuel. (para 8b.

DO YOU UNDERSTAND EVERYTHING IN THIS PROGRAMED REVIEW? HAVE YOU CHECKED YOUR RESPONSES, MADE CORRECTIONS, AND RESTUDIED THE TEXT, IF NECESSARY? IF YOU HAVE, GO ON TO THE NEXT STUDY UNIT OF THIS SUBCOURSE.

APPENDIX
REFERENCES

AR 700-36	Quality Surveillance and Laboratory Facilities for Petroleum Products in Overseas Areas
AR 703-1	Petroleum Management - Petroleum Supply and Management Activities
TM 10-1101	Petroleum Handling Equipment and Operation
FM 10-70	Inspecting and Testing Petroleum Products
MIL-HDBK-2000	Military Standardization Handbook - Quality Standardization Handbook for Fuels, Lubricants, and Related Products
DOD 4140.25M	Procedures for the Management of Petroleum Activities
Federal Supply Catalog-Identification List C-9100-IL (on microfiche)	Fuels, Lubricants, Oils, and Waxes
Federal Specifications	
VV-F-800A	Fuel Oil, Diesel
VV-F-815C	Fuel Oil, Burner
VV-G-76B(1)	Gasoline, Automotive
VV-G-632	Grease, Industrial, General Purpose
Military Specifications	
MIL-F-859E(2)	Fuel Oil, Burner
MIL-F-16884G	Fuel Oil, Diesel, Marine
MIL-G-3056C	Gasoline, Automotive, Combat
MIL-G-10924C(1)	Grease, Automotive and Artillery
MIL-G-18709A(3)	Grease, Ball and Roller Bearing (Navy)
MIL-I-27686E	Inhibitor, Fuel System Icing
MIL-L-15012B-AM1	Lubricating Oil
MIL-L-15018A	Lubricating Oil
MIL-P-S-661	Solvent, Dry Cleaning (Stoddard)
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4, and JP-5

PROGRAMED REVIEW A

SOLUTIONS

Exercises	Solution
A1	part 2
A2	Military Specification, serial number
A3	automotive, aviation
A4	gasoline, kerosene
A5	burner fuels
A6	SAE, OE
A7	drycleaning solvent
A8	qualified products list
A9	examined, tested
A10	origin

PROGRAMED REVIEW B

SOLUTIONS

Exercise	Solution
B1	petroleum products
B2	freeze order
B3	petroleum problems
B4	New Cumberland Army
B5	Sharpe Army
B6	reclamation, disposal
B7	Military Department
B8	Joint Petroleum Office
B9	deterioration, contamination
B10	contamination with other petroleum products and contamination with water and solids
B11	off-specification
B12	downgrading, blending, disposal
B13	downgraded, automotive

LESSON 3 Credit Hours: 1

LESSON ASSIGNMENT

SUBJECT	Military Petroleum Pipelines.
STUDY ASSIGNMENT	Lesson Text.
SCOPE	Components of a military pipeline; advantages and disadvantages of pipelines; and identification of pipelines operated by the US Army in World War II and currently.
OBJECTIVES	As a result of successful completion of this assignment, you will be able to--

1. Identify the components of a military pipeline and indicate the function of each.
2. Specify the advantages and disadvantages of pipeline operations.
3. Identify pipelines operated by the US Army in World War II.
4. Describe pipelines currently operated by the US Army.

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Military pipelines classified according to construction	3	62
Composition of a military petroleum pipeline system	4	62
Advantages and disadvantages of military petroleum pipelines	5	67
Military pipelines of World War II	6	68
Military pipelines of today	7	68
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ILLUSTRATIONS

FIGURE	CAPTION	PAGE
1	Typical military bulk petroleum supply and distribution system.	63
2	Tank farm.	64
3	Pipeline terminals in a theater of operations.	65
4	Typical division of a military pipeline into districts.	66

LESSON TEXT

1. INTRODUCTION. A military petroleum pipeline can be defined as a line of pipe with pump machinery and apparatus for carrying petroleum products. Military pipeline systems can be classified according to their use or their construction. There are three general classifications according to use; there are three general types according to construction.

2. MILITARY PIPELINES CLASSIFIED ACCORDING TO USE. The three classifications according to use are assault, tactical, and logistical.

a. ASSAULT SYSTEM. This system is generally a temporary one that can be installed to provide petroleum products to the using element in an assault or rapidly moving combat situation. A hoseline, similar to a firehose used to carry water from a hydrant to the location of a fire, is an example of this type of system.

b. TACTICAL SYSTEM. This system can be constructed rapidly and can supply sufficient fuel for a corps or theater army. A coupled pipeline advancing close behind troops as they move forward is an example of a tactical system.

c. LOGISTICAL SYSTEM. This is a permanent or semipermanent system designed to provide large quantities of fuel to a stabilized area. The North Atlantic Treaty Organization (NATO) system extending from the southwest coast of France into Germany, and the 600-mile "8-inch" system extending from Haines to Fairbanks, Alaska, are examples of a logistical system.

3. MILITARY PIPELINES CLASSIFIED ACCORDING TO CONSTRUCTION. The three classifications of military pipelines according to construction are welded, coupled, and hoseline. All three are used in a typical military bulk petroleum distribution. Welded construction is used mostly for ship-to-shore tanker unloading lines (submarine or dock) or at locations where buried pipelines (marine storage complexes, river and road crossings, and the like) are required. Coupled construction is used chiefly for main and branch pipelines, and hoseline construction is generally used in support of assault operations and in extending the military pipeline system forward.

4. COMPOSITION OF A MILITARY PETROLEUM PIPELINE SYSTEM. A military bulk petroleum pipeline system in a theater of operations (fig. 1) may consist of one or more of the elements described in the subparagraphs below. All elements are constructed by engineer troops except as noted.

a. SHIP-TO-SHORE AND DOCKSIDE TANKER UNLOADING FACILITY. In an oversea theater, a military bulk petroleum supply and distribution system begins at a port of debarkation where the product is unloaded from tankers. In protected waters, a jetty with a wharf is extended up to 1,000 feet offshore and the pipeline is carried to shore over the jetty. The tanker docks at the wharf and unloads the product through the pipeline. In unprotected waters, a submarine pipeline is extended from shore to a ship mooring located offshore in safe waters. At the sea end, the line is connected to an 8- or 12-inch flanged discharge hose, usually 150 to 200 feet long. The free end of the hose is closed with a plug valve and blank flange and is attached to a marker

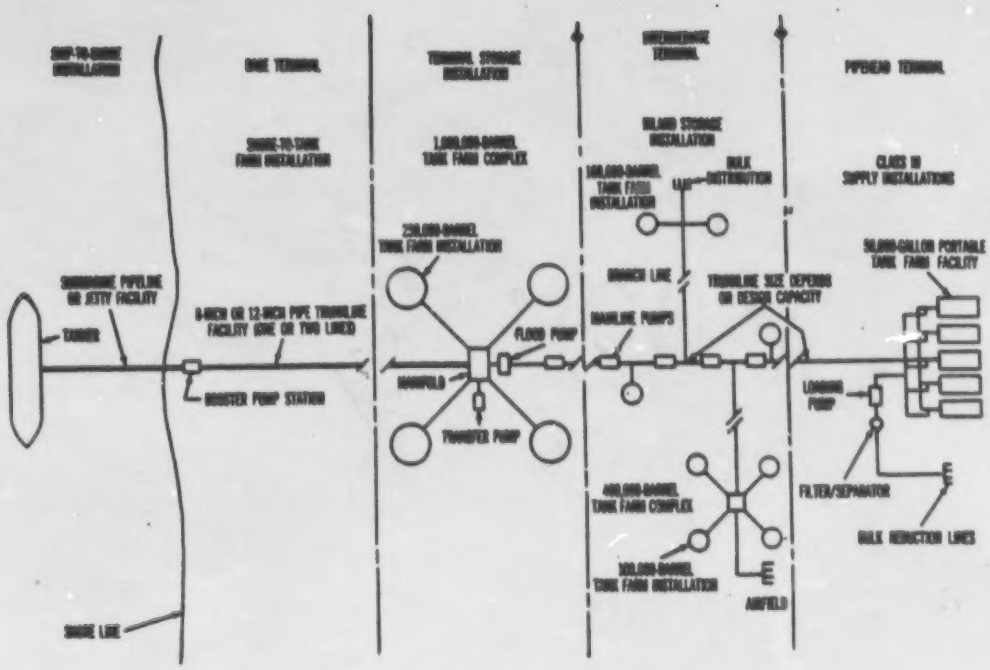

Figure 1. Typical military bulk petroleum supply and distribution system.

buoy with a lifting chain to make the hookup with the tanker easier. The tanker anchors by the buoy and unloads through the hose and marine pipeline. Unloading facilities should be able to unload the largest tanker in less than 24 hours.

b. BASE TERMINAL STORAGE INSTALLATION. From the tanker unloading facility (submarine, jetty, or dockside), the fuel is pumped forward to base terminal storage installations. The base terminals are composed of tank farms and tank farm complexes, depending on requirements. Tank farms (fig. 2) are clusters of storage tanks and pumps, interconnected by pipelines and manifolded so that one to four petroleum products can be moved into, out of, or between tanks. One tank farm usually has a capacity of up to 250,000 barrels. When requirements exceed this quantity, a tank farm complex of two, three, or four tank farms may be erected and connected by a central switching manifold.

c. MAIN AND BRANCH PIPELINES. From the ship-to-shore or dockside unloading line, the fuel flows to the base terminal storage facility through a mainline that is usually constructed of 12-inch diameter pipe. Usually, only one main pipeline is required to support a 200,000-barrel base terminal; two or more lines are provided for terminals having a capacity of 400,000 barrels or more. From the base terminal, the mainline is extended forward (possibly reduced to a 6- or an 8-inch pipeline) to follow the course of battle. Branch lines are connected to the mainline to serve intermediate terminal storage facilities and bulk-reduction points and airfields. These branch pipelines may be constructed of 4-, 6-, or 8-inch pipe, depending on the capability of the facilities they serve.

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Figure 2. Tank farm.

d. PUMP UNITS. Pumps perform many important functions in a military pipeline system. In regulating distribution, they act as the heart of the pipeline system. By different arrangement of its manifold, one pump may be used to perform more than one function.

(1) STATION PUMPS. The type of pump used for pipeline pump stations is determined by the size of the pipeline. Lines constructed of 4- and 6-inch lines call for 4-inch, four-stage pumping units; 8- and 12-inch lines call for 6-inch, two-stage or 6-inch, multistage pumping units.

(2) BOOSTER PUMPS. Tankers usually have two or more pumps capable of off-loading to the terminal storage tanks. However, shore booster pumps will be necessary for a long ship-to-shore pipeline or a long line from the dock to storage, or for terminal storage considerably above sea level. The 6-inch, two-stage, self-priming, pump unit can be used with the 8- to 12-inch lines from the tankers.

(3) FLOOD PUMPS. Flood (or feeder) pumps usually are installed to supply the required suction pressure between tank farm installations and main line (truck) pumping stations, or to feed fuel through short branch lines to dispensing tankage installations.

(4) TRANSFER AND TANK PUMPS. Transfer and tank pumps are connected with the switching manifold of tank farm installations to move large volumes of petroleum products into, out of, and within the tank farm. The purpose of such pumping may be to transfer fuel from damaged or leaking tanks to sound ones, to consolidate in one tank fuel from several partly empty tanks, to empty tanks to provide space for new fuel shipments which should not be mixed with existing supplies before testing, or to blend different batches of fuel to uniform specifications. Depending on the elevation and other site conditions, tank pumps may be used to relay tank contents to dispensing tanks.

(5) LOADING PUMPS. Loading pumps usually are needed to relay petroleum products from tankage to the dispensing outlets unless the required rate of flow is supplied by a gravity system. Loading pumps usually are used for tank car and tank truck filling installations.

e. SWITCHING MANIFOLD. The switching manifold is an assembly of 4-, 5-, 6-, 8-, or 12-inch pipe, fittings, and valves used for controlling the flow of petroleum products into, out of, and within a tank farm.

f. INTERMEDIATE TERMINALS. Intermediate terminals (fig. 3) are located along the main line where the pipeline extends over a considerable distance. They are usually located where branch lines leave the main line. These terminals may serve both as reserve storage and as dispensing installations. The size or number of tanks depends on requirements. However, operations usually require at least two 10,000-barrel tanks for each type of fuel transported, so that one tank can receive the product while the other is delivering it to the dispensing facility.

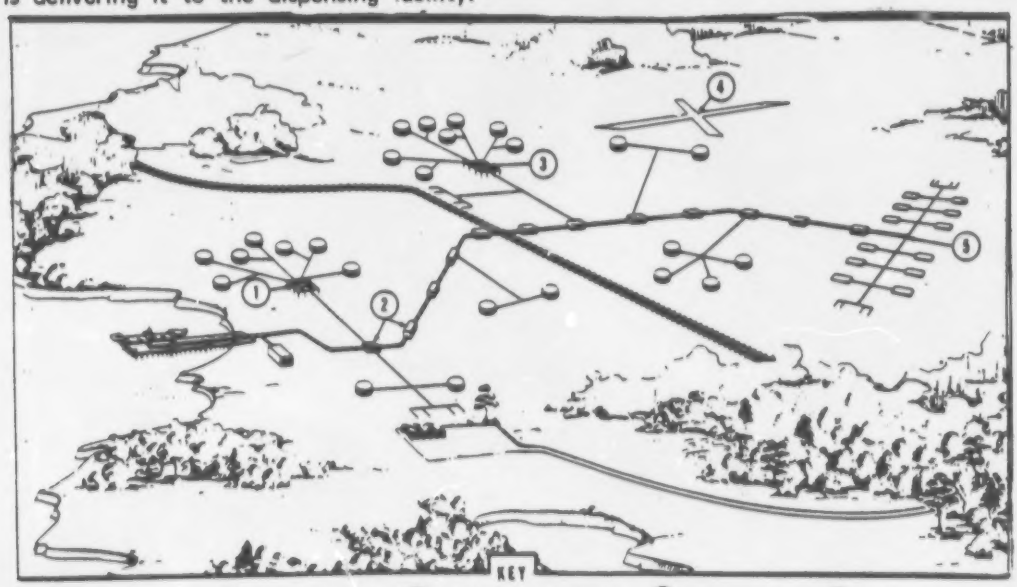

Figure 3. Pipeline terminals in a theater of operations.

g. PIPEHEAD TERMINALS. A pipehead terminal is a bulk storage point located at the head of a pipeline system. Tankage for these terminals may be portable or fixed, depending on requirements. Portable pipeheads usually consist of portable tank farms; they may move forward with the advance of class III supply points. Fixed pipehead terminals consist of bolted steel tanks; they are used to furnish fuel for airfields and clusters of class III supply points.

h. BULK-REDUCTION DISPENSING FACILITIES. Bulk-reduction dispensing facilities are installed at points from which bulk fuel is transferred from the pipeline system to other means of transportation (tank trucks and tank cars) or where it is packaged or delivered to the using vehicles. Army bulk-reduction points may include facilities for transferring bulk supply to tank trucks and tank cars. Filling stations for dispensing fuels may be established near depot, supply points, railheads, bivouac areas, rest camps, and similar areas.

i. PIPELINE DISTRICTS. For efficient operation and control, a military pipeline is usually divided into districts (fig. 4), which are numbered consecutively. Each district includes a district terminal and a number of integral pipeline pump stations. The district terminal for district 1 is usually the base terminal. Intermediate terminals, most often located at takeoff points for branch pipelines, serve as district terminals for their respective districts.

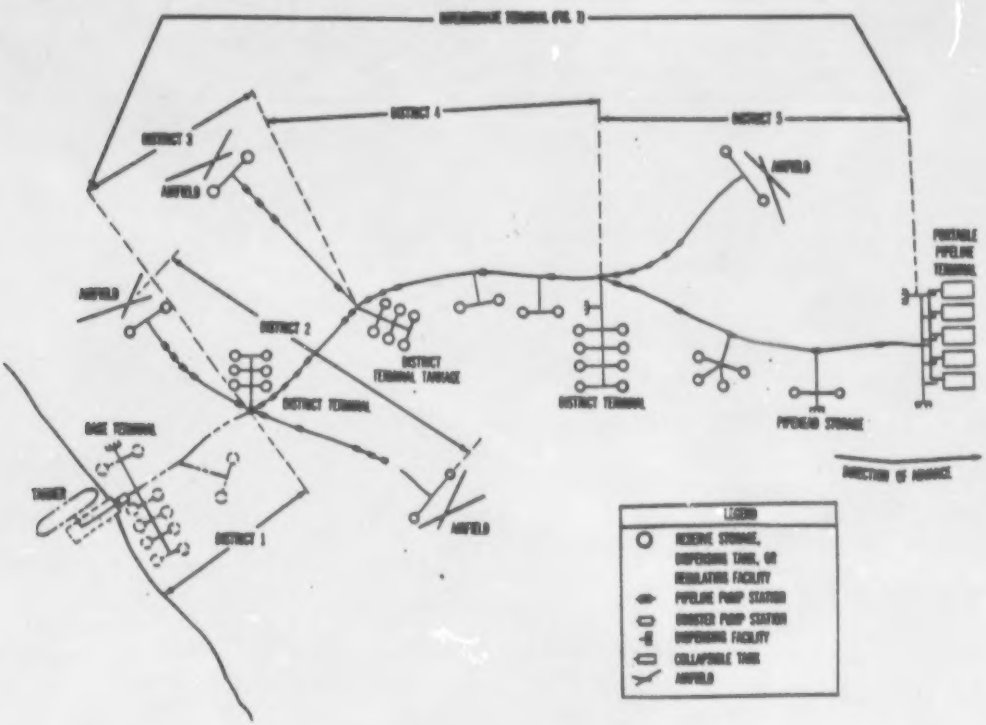

Figure 4. Typical division of a military pipeline into districts.

(1) The military services have tank farms capable of storing approximately 1,750,000 barrels of bulk POL products. Of this total, the Army's tank farm capacity is 1,340,000 barrels; 480,000 barrels of this total are under ground. The Air Force storage capacity located at Kadena, Yomitan, Futenma, and Naha air bases is about 410,000 barrels. Storage for an additional 500,000 barrels is available in commercial facilities, making an island total capacity of 2,250,000 barrels.

(2) Naha Port and White Beach have a total Navy Special fuel oil storage capacity of 300,000 barrels. These locations are not connected to the pipeline system.

d. KOREA. The US Army pipeline in Korea includes a 10-inch welded, taped, buried, and cathodically protected line that starts at Pohang on the east coast; runs to Taegu, Waegwan Terminal, Taejon, Camp Humphreys, and to Osan Air Force Base, where it is reduced to an 8-inch line which continues to Seoul. The system covers 248.8 miles and is capable of carrying 50,000 barrels per day to Waegwan and 40,000 barrels per day to Seoul. There are five pump stations along the line, spaced approximately 31 miles apart. Each pump station consists of two 2-stage centrifugal pumps. Major terminals and their storage capacities are as follows:

(1) POHANG BASE TERMINAL. The Pohang base terminal has a storage capacity of 514,000 barrels. The terminal is capable of unloading T-1 and T-2 class tankers. JP4, Avgas, Mogas, and DFM are stored at Pohang.

(2) WAEGWAN INTERMEDIATE TERMINAL. The Waegwan terminal has a storage capacity of 140,000 barrels. JP4, Mogas, and DFM are stored at Waegwan.

(3) INCHON TERMINAL. The Inchon terminal is Operated by the Korea Oil Company and is capable of storing 643,000 barrels. This terminal has two 12-inch sea lines for off-loading tankers.

(4) OTHER TERMINALS. Other terminals are located at Seoul (60,000-barrel capacity), Kunsan (30,000-barrel capacity), Taejon (40,000-barrel capacity), and Pyonteak (96,000-barrel capacity), Pohang (514,000-barrel capacity), Waegwan (140,000-barrell capacity) and Uijong-Bu (28,000-barrel capacity).

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at Zweibrucken: the 10-inch Zweibrucken-Metz Line, the 8-inch Phalsbourg-Zweibrucken Line, the 6-inch Zweibrucken-Bitburg Line, the 6-inch Zweibrucken-RCAF Base Line, and the 6-inch Zweibrucken-Contwig Line. The five NATO lines are capable of pumping in either direction.

b. ALASKA. The Alaskan petroleum distribution unit consists of the Haines-Fairbanks Pipeline system and waterfront terminals at Haines, Whittier, and Anchorage, and an 8-inch pipeline connecting Whittier and Anchorage.

(1) THE HAINES-FAIRBANKS PIPELINE. This pipeline begins at Lutak Inlet at Haines, Alaska. It follows the Haines Highway into Haines Junction, Canada; and then follows along the Alcan Highway via Tok Junction, Fort Greely; and Big Delta Junction, Eielson Air Force Base; to its terminus at Ft. Wainwright, near Fairbanks. It is a multiproduct line carrying avgas, mogas, and diesel and jet fuel. This line consists of 626 miles of 8-inch high pressure pipeline, of which 148 miles are buried, and 478 miles are above ground. There are 11 pump stations on the line. The average discharge pressure is 1,150 psi, which moves the product at 15,000 barrels per hour. From Haines, 30 feet above sea level, the line reaches an elevation of 3,750 feet 57 miles inland, and then decreases to an elevation of 425 feet at Fairbanks. Along its route, the line passes over 25 major rivers, 82 minor streams, 49 major highways, 39 secondary roads, and 11 major swamps and tundras. The portion between Haines and Tok was closed in 1971, leaving only the 148 miles between Tok and Fairbanks open. The major function of the Tok to Fairbanks section is to supply fuel to Eielson Air Force Base. Temperatures along the pipeline route have ranged from a low of 83 degrees at Snag, Yukon Territory, to a high of 92 degrees at Fairbanks, a variation of 175 degrees. Liquid fuels contract and expand with temperature changes, and line pressures and flow rates are directly affected. For example, during a temperature rise, it has been possible to receive 1,000 barrels per hour at Tok while Haines has been pumping only 500 barrels per hour. During a rapid fall in temperature, Haines may pump 500 barrels per hour, and Tok may receive nothing for 2 1/2 hours.

(2) THE WHITTIER-ANCHORAGE PIPELINE. This pipeline is an 8-inch welded high-pressure line that begins at Prince William Sound at Whittier and terminates 68 miles away at Anchorage. The one pump station on the line is located at Indian, Alaska; the station is completely automated and is controlled by the dispatcher at Fort Richardson, Alaska. The average discharge pressure is 1,200 pounds per square inch (psi), which moves the product at approximately 27,000 barrels per day. From Whittier, 50 feet above sea level, the line reaches an elevation of approximately 3,500 feet 40 miles inland; it then decreases to an elevation of approximately 200 feet at Anchorage. The line is operated as a multiproduct line carrying avgas, mogas, diesel fuel and jet fuel.

c. OKINAWA. The military petroleum pipeline system in Okinawa consists of three buried, parallel 8-inch lines. The total system extends over a distance of 130 miles. The lines running from Chimu-Wan to Naha, a distance of 33 miles, can transport in either direction. Tankers can be unloaded at Tengan and Kin through 14-inch submarine lines from ships anchored offshore. Tankers of the super class (400,000-barrel capacity) can be unloaded at three facilities at rates of 7,000 to 10,000 barrels per hour. Three additional tanker pier facilities, one at White Beach and two in the Naha Port area, can accommodate tankers of the T-2 class (cargo capacity 138,335 barrels) with a discharge rate of 1,000 barrels per hour at Naha and 3,000 barrels per hour at White Beach.

decoy installations. Damage from such attacks can be reduced through the use of fire and damage control methods.

(4) CONSTRUCTION LAGS. In a rapidly changing situation, the rate of pipeline construction may lag behind the rate of combat advance. Construction rate may vary from 2 to 10 miles per day, depending on the terrain and the capability of the engineer personnel involved in the construction.

6. MILITARY PIPELINES OF WORLD WAR II. During World War II, approximately 50 percent of the total logistical tonnage in the European Theater was petroleum fuels. To meet this demand, two pipelines were constructed in the United States to move POL products to the port of embarkation for delivery to Europe. These pipelines ran from Texas to the East Coast. One was a 24-inch pipeline, called the Big Inch, that extended a total of 1,200 miles. The other was a 20-inch pipeline (Little Big Inch) that extended 1,475 miles. In addition to these two pipelines in the United States, almost 8,000 miles of pipeline was constructed overseas. Twenty 3-inch lines were laid from England to France. Three 6-inch lines were begun in France 3 days after D-day and were built from Cherbourg across France to the Rhine as the armies advanced. After the invasion of Southern France, 4- and 6-inch lines were laid north to Germany, and a third series of four 4-inch lines were laid from Antwerp to Germany. In the China-Burma-India theater, lines were laid from Calcutta all the way into China over the Himalayas, a distance of some 1,835 miles.

7. MILITARY PIPELINES OF TODAY. Military pipelines of interest today are those in Europe, Alaska, Korea, and Okinawa.

a. EUROPE. The US Army pipeline in Europe consists of the Donges-Metz Pipeline (under French control since the withdrawal of US forces in 1966 and 1967) and the Zweibrucken-Huttenheim Pipeline. These two lines are connected by a 90-mile portion of the European NATO Pipeline System.

(1) DONGES-METZ PIPELINE IN FRANCE. The Donges-Metz Pipeline extends from Donges, in the vicinity of St. Nazaire, to St. Baussant, which is located about 35 miles southwest of Metz. From Donges to Chalons the line is 12 inches in diameter. From Chalons to St. Baussant it is 10 inches in diameter. The Donges-Metz system handles marine diesel fuel; grade 2 diesel fuel; aviation gasoline (avgas); jet propulsion fuel, grade 4; and automotive gasoline (mogas). The French Government pumps approximately 240,000 barrels per month from Donges to Zweibrucken, West Germany.

(2) THE ZWEIBRUCKEN-HUTTENHEIM PIPELINE. This pipeline originates at the Walhausen B pump station approximately 7.5 miles southwest of Zweibrucken, Germany. It follows German Federal Highway 10, bypasses the city of Landau, and terminates at the Huttenheim tank farm on the east bank of the Rhine River. The line is approximately 55 miles long and is buried 3 feet below the ground surface. It is coated, wrapped, and cathodically protected. The line is 8 inches in diameter from Walhausen to Bellheim and 6 inches in diameter from Bellheim to Huttenheim. The line is equipped with three high-pressure pump stations (Walhausen-B, Hinterweidenthal, and Bellheim) and is connected to tank farms (Zweibrucken-NATO operated, Hinterweidenthal, Bellheim, and Huttenheim). There is a barge loading and unloading facility at Sonderheim, on the west bank of the Rhine River. Five NATO pipelines either originate or terminate

j. COMMUNICATIONS SYSTEM (SIGNAL CORPS CONSTRUCTION). An extensive system of communications is essential for construction, operation, and maintenance of military pipelines. The communications system must be separate, continuous, and dependable. A typical pipeline communications net includes telephone, teletype, and radio communications circuits. The communications system provides for dispatch and interterminal and intraterminal service.

5. ADVANTAGES AND DISADVANTAGES OF MILITARY PETROLEUM PIPELINES. Military petroleum pipelines usually extend over many miles of territory and include terminals, tank farms, pump stations, regulating tanks, and other related facilities. Because of their great length and complexity, there are both advantages and disadvantages of using pipelines for supplying bulk petroleum products in a theater of operations.

a. ADVANTAGES. The huge quantities of liquid fuels required in modern warfare make up over half the total tonnage of equipment and supplies moving into theaters of operations. Moving this tonnage within the theater by means of pipelines has the following advantages:

(1) It releases a large number of vehicles and personnel for other essential supply activities and reduces the need for tank trucks, tank semitrailers, and railroad tank cars.

(2) Although adverse weather conditions may hinder construction and repair work, they present less serious problems to pipeline operations than to vehicular transport.

(3) Pipelines can be laid over terrain that is too rugged for roads or railroads.

(4) Pipelines and their pump stations are less vulnerable to air attacks than are tank vehicles and railroad tank cars. They can be camouflaged easily because they can be located to take advantage of natural foliage; therefore, they do not offer an easy target for enemy air attack. If a short portion of the line is damaged (five or six sections), repairs can be made quickly.

b. DISADVANTAGES. There are many disadvantages in using military pipelines to deliver POL products. Several disadvantages are as follows:

(1) TAMPERING AND PILFERAGE. Pipelines are vulnerable to sabotage in occupied enemy territory, and isolated pump stations are prime targets for guerrilla raids. In friendly territory, pipelines are often subject to tampering and pilfering by area citizens. This disadvantage can be partially overcome by burying the pipeline.

(2) TIME TO REPAIR. If a long portion of pipeline is damaged, the result can be serious. Locating leaks in the pipeline takes time, and repairing the line is costly and takes additional time. Also, fire may break out, and the line cannot be repaired until the fire is extinguished.

(3) AIR ATTACK TARGET. Base-terminal installations and tank farm complexes make ideal targets for enemy air and missile attacks. However, such attacks can be reduced through the use of camouflage, concealment, dispersion and dummy and

PROGRAMED REVIEW

The questions in this programed review give you a chance to see how well you have learned the material in lesson 3. The questions are based on the key points covered in the lesson.

Read each item and write your answer on the line or lines provided for it. Please use a pencil to write your answers. If you do not know, or are not sure, what the answer is, check the paragraph reference that is shown in parentheses right after the item; then go back and study or read once again all of the referenced material and write your answer.

After you have answered all of the items, check your answers with the Solution Sheet at the end of this lesson. If you did not give the right answer to an item, erase it and write the correct solution in the space instead. Then, as a final check, go back and restudy the lesson reference once more to make sure that your answer is the right one.

A1. In protected waters, one component of a military pipeline system enables petroleum pipelines to be extended from the shore to the tanker. That component is called a _____. (para 4a)

A2. Product from tankers is pumped through pipelines to another component of a military pipeline system. It is called the base terminal storage facility which is composed of _____ _____. (para 4b)

A3. Another component of a military pipeline system enables the product to flow forward to follow the course of battle. This component is called the _____ _____. (para 4c)

A4. Those components that form the heart of military pipeline system are its pump units. They may be used as flood pumps, transfer and tank pumps, _____ pumps, or _____ pumps. (para 4d(2) and (3))

A5. Other components of a military pipeline system are the terminals located along the main line where the pipeline covers a considerable distance. They are called _____ terminals. (para 4f)

Exercises A6 through A8 are matching. Column I lists advantages and disadvantages of using a petroleum pipeline in a theater of operations. Column II lists the answers. Select the correct answer from column II, and enter in the blank before the exercise either A for advantage or B for disadvantage. Answers from column II may be used once, more than once, or not at all.

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Column I	Column II
_____ A6. Not seriously affected by adverse weather. (para 5a(2))	A. Advantage.
_____ A7. Suitable to rugged terrain. (para 5a(3))	B. Disadvantage.
_____ A8. Vulnerable to sabotage and pilferage. (para 5b(1))	

A9. Two pipelines were constructed in the United States to support military needs in World War II. These lines moved petroleum from Texas to the port of embarkation for delivery to _____. (para 6)

A10. During World War II, troops advancing across France were supported by three 6-inch pipelines laid across France from Cherbourg to the _____ river. (para 6)

A11. The US Army petroleum pipeline in Germany includes three high pressure pump stations, four tank farms (excluding NATO operated farms), and a _____ loading and unloading facility. (para 7a(2))

A12. The two Army pipelines in Alaska are both _____ pipelines. (para 7b(1) and (2))

A13. The major function of the 8-inch pipeline from Tok to Fairbanks, Alaska is to supply petroleum to _____ Air Force Base. (para 7b(1))

A14. The military pipeline system on Okinawa consists of three _____ parallel 8-inch lines. (para 7c)

A15. The US Army pipeline in Korea runs more than 248 miles from Pohang to _____. (para 7d)

DO YOU UNDERSTAND EVERYTHING IN THIS PROGRAMED REVIEW? HAVE YOU CHECKED YOUR RESPONSES, MADE CORRECTIONS, AND RESTUDIED THE TEXT, IF NECESSARY? IF YOU HAVE, GO ON TO THE NEXT STUDY UNIT OF THIS SUBCOURSE.

APPENDIX

REFERENCE

FM 10-18	Petroleum Terminal and Pipeline Operations
FM 10-67	Petroleum Supply in Theaters of Operations

PROGRAMED REVIEW

SOLUTIONS

Exercise	Solution
A1	jetty
A2	tank farms
A3	main pipeline
A4	booster, loading
A5	intermediate
A6	A
A7	A
A8	B
A9	Europe
A10	Rhine
A11	barge
A12	multiproduct
A13	Eielson
A14	buried
A15	Seoul

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Correspondence Subcourse Examination

EXAM 142
Ed 8

Credit Hours: 1

EXAMINATION ASSIGNMENT

SUBJECT	Petroleum Equipment and Technical Operations
STUDY ASSIGNMENT	Review all previous assignments.
SCOPE	Description and operation of petroleum handling equipment; quality surveillance and petroleum testing facilities; and military petroleum pipelines.
OBJECTIVES	To test knowledge of the instruction given in the lessons and to emphasize points that have been previously studied.

EXAMINATION EXERCISES

REQUIREMENT. Exercises 1 through 38 are multiple choice. Each exercise has only one single-best answer. Indicate your answer on the answer form.

1. A spring-loaded, fusible link release lever in the control assembly of the 2 ½-ton fuel-servicing tank truck is used to

   a. close all valves in case of a fire in the equipment compartment.

   b. limit the flow of fuel through the compartment of 80 gpm.

   c. allow the product to be distributed evenly among the four compartments.

   d. regulate the engine's speed when the power takeoff is engaged for pumping fuel.

2. The meter of the 2 1/2-ton fuel-servicing tank truck is used to

   a. regulate fuel output.

   b. register engine speed.

   c. register total output.

   d. record pump pressure.

3. The chief function of the filter/separator on the 2 1/2-ton fuel-servicing tank truck is to

   a. close the discharge valve controls during travel.

   b. collect solid contaminants and separate water from fuel.

   c. register total output from the fuel compartment and reset the meter.

   d. limit the flow of the displacement pump to 60 gpm.

EXAMINATION CONTINUES

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4. The manifold on the 5,000-gallon fuel-servicing semitrailer is used to

   a. open and close the fuel compartments.

   b. remove solid contaminants and remove water from the product.

   c. distribute the product to and from each compartment.

   d. load and unload the product in the tank.

5. The Model M131A4 fuel-servicing semitrailer cannot be used for refueling aircraft because it

   a. does not have a filter/separator.

   b. is not capable of hauling aviation gasoline.

   c. does not have the necessary carrying capacity.

   d. is not equipped with fire extinguishing equipment.

6. The fuel system supply point is designed to do all except which one of the following?

   a. Receive petroleum products.

   b. Store petroleum products.

   c. Issue petroleum products.

   d. Test petroleum products.

7. SITUATION. Some of the items below are considered desirable when selecting a site for a fuel system supply point. Some of the items are not desirable.

ITEM 1. Level area.

ITEM 2. Variation in height of land (hilly, sloping).

ITEM 3. Natural cover.

ITEM 4. Near roads and airfield.

ITEM 5. As far from beaches and airfields as possible.

ITEM 6. Near the corps rear area.

Select the choice below that contains the number of ALL items above that are considered desirable for locating a site for a fuel system supply point.

a. ITEMS 1, 3, and 4.

b. ITEMS 2, 5, and 6.

c. ITEMS 2, 3, and 4.

d. ITEMS 1, 3, and 5.

8. The components of the fuel system supply point may be modified by using the pump assembly for receiving and dispensing fuel. When this is done and the manifold is connected into both sides of the system, what benefit is derived from this change?

a. Fuel pumping ability of the system is tripled.

b. System is then capable of a drum-cleaning service.

c. There is less wear and tear on equipment.

d. Equipment can receive and disburse two fuels at the same time.

EXAMINATION CONTINUES

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9. One purpose of using gaging equipment is to determine the quantity of fuel in a tank. Gaging equipment is also used to

   a. record temperature of the air surrounding the tank.

   b. measure depth of sediment and water at bottom of tank.

   c. measure the octane rating of fuel stored in tank.

   d. detect the presence of other products mixed with fuel.

10. A tape and bob is used to measure petroleum product volume by determining the distance from the bottom of the tank to the surface of the product. This type of measurement is known as

   a. surface gaging.

   b. outage gaging.

   c. innage gaging.

   d. tape and bob gaging.

11. In the specification VV-F-800, the VV designates

   a. Military Specification.

   b. Joint Army-Navy Specification.

   c. Military Petroleum Specification.

   d. Federal Specification.

12. In the specification MIL-G-3056C, the G is the first letter of the product nomenclature and the C indicates that the specification is a

   a. revision.

   b. change.

   c. rewrite.

   d. new publication.

13. What product may be procured through use of Federal Specification VV-G-76C?

a. Ball bearing grease.

b. Aviation gasoline.

c. Combat automotive gasoline.

d. Commercial automotive gasoline.

14. In addition to specialty items, what are the categories of petroleum products?

a. Waxes, greases, and aviation gasoline.

b. Hydraulic fluids, automotive fuels, and greases.

c. Lubricating diesel fuel, and insulating oils.

d. Automotive/aviation fuels, burner fuels, and lubricants.

15. Which of the following groups of POL products represents all major categories of petroleum products used by the US Army?

a. Gasoline, preservative compounds, jet fuel, and greases.

b. Rocket fuel, jet fuel, gasoline and specialty products.

c. Automotive and aviation gasolines, burner fuels, lubricants and specialty items.

d. Automotive, combat gasoline; jet fuels; aviation gasoline, and lubricating oils and greases.

EXAMINATION CONTINUES

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16. The purpose of qualification testing of POL products used by the Army is to

a. determine that the quality of POL products in storage retain the high quality standards prescribed by the specification.

b. insure that all fuel products are laboratory tested by approved USAGMPA depots.

c. determine if petroleum products in depot storage should be "frozen" until the quality of product is determined.

d. insure that POL products accepted by the Army meet established standards and are compatible with products of other manufacturers.

17. You are the motor officer with the 13th QM Bn, Petroleum Supply Company, located at Fort School, Virginia. You have been informed that the gasoline in your storage tanks is contaminated. Where do you send a sample to be tested?

a. Defense Fuel Supply Center, Alexandria, Virginia.

b. US Army Depot, New Cumberland, Pennsylvania.

c. Sharpe Army Depot, Lathrop, California.

d. US Army Arsenal, Rock Island, Illinois.

18. Which of the following activities serves as the Technical Quality Office for the Army and has authority to deviate from contract specifications for petroleum products?

a. Sharpe Army Depot, Quality Control Division.

b. New Cumberland Army Depot, US Army Materiel and Petroleum Activity.

c. Defense Fuel Supply Center, Installation Storage Activity.

d. Defense Logistics Agency.

19. Petroleum products are on specification when they

a. are sampled and tested periodically.

b. have certain critical properties that permit them to be upgraded.

c. leave no residue.

d. equal or exceed specification requirements.

20. One of the basic objectives of the Army's quality surveillance program is to insure that

a. the Government receives the quality and quantity of products specified in a contract.

b. military departments maintain on-specification product standards.

c. petroleum laboratories upgrade off-specification products so that they may be used.

d. all products are consumed within the same year in which they are purchased.

21. The Installation Quality Surveillance Program of the Army provides

a. new procurement sources for gasolines and motor oils.

b. technical advice on POL problems to installation commanders.

c. inspection and testing of depot POL stocks.

d. laboratory testing of samples of petroleum products.

EXAMINATION CONTINUES

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22. The Storage Quality Surveillance Program of the Army provides

a. for quality inspection of POL products at Army installations.

b. technical advice to installation commanders on POL problems.

c. for inspection of POL products to determine if products are off-specification.

d. laboratory testing at each installation for all petroleum products.

23. The main purpose of the Technical Advisory Program of the Army is to help installation commanders determine whether

a. POL products meet initial contract acceptance standards.

b. POL samples submitted by installations meet specification requirements.

c. POL products and handling facilities are managed according to instructions.

d. POL products received from commercial terminals meet specification requirements.

24. When forces overseas are operating under a unified command, which of the following is responsible for quality surveillance?

a. Department of the Army.

b. Department of the Navy.

c. Joint Petroleum Office.

d. Department of the Army Force.

25. In Armed forces overseas the quality surveillance program is the responsibility of the

a. Commander, Theater of Operations.

b. US Army.

c. Department having physical possession of the product.

d. US Air Force.

26. Which one of the following represents two major causes of off-specification in petroleum products?

a. The purchase of two different brands of fuel or two categories of petroleum, oils, lubricants (POL) products.

b. Sediment in the fuel or microbiological growth in the fuel storage tank.

c. Slight variance of octane rating and particles of moisture.

d. Mixing high and low octane motor fuel into one blend.

27. What are three major causes of off-specification of petroleum products?

a. Evaporation, gum formation in the petroleum product, and chemical impurities.

b. Contamination with solid impurities and microbiological growth, and fungus.

c. Deterioration, contamination, and microbiological growth.

d. Contamination with water, with other petroleum products, and with soil.

28. How does evaporation affect the quality of automotive and aviation fuels?

a. Causes loss of additive during long periods of storage.

b. Unsaturated hydrocarbons unite with oxygen to form gum.

c. Causes a decrease in gum content in fuel.

d. Makes it more difficult to start engines in cold temperatures.

29. When ordinarily clear fuels have a slight haze (cloud), what is this a sign of?

a. Coarse sediment that usually settles to bottom of fuel tank.

b. The presence of other types of fuel mixed with the primary fuel.

c. Fine sediment too small to be seen with the naked eye.

d. The presence of dissolved water particles too small to be seen.

EXAMINATION CONTINUES

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30. What are three major causes of POL contamination?

a. Evaporation, gum formation, and loss of additive.

b. Sediment, water, and microbiological growth.

c. Salt water, gum formation and sediment.

d. Water, other POL products, and solids.

31. The petroleum laboratory to which you forwarded fuel samples in exercise 17 notifies you that the product tested below specification standards but within allowable limits. What disposition instructions are you most likely to receive?

a. Use it for upgrading regular automotive fuel to premium grade.

b. Turn quantity over to property disposal for sale or destruction.

c. Use it for its intended purpose.

d. Return entire quantity to laboratory so that it can be re-refined.

32. An important element in unloading tankers at a port of debarkation is a

a. tank farm complex.

b. branch pipeline.

c. jetty.

d. manifold.

33. In each choice below, one element of the military pipeline system is paired with a characteristic of an element. Choose the one that is correctly paired.

a. Ship-to-shore unloading facility--security manifold.

b. Base terminal storage installation--tank farm.

c. Main and branch pipelines--4-inch diameter pipe.

d. Intermediate terminal--dockside facility.

34. Which of the following is an advantage in using pipeline instead of vehicles for moving a petroleum product?

a. It is less vulnerable to sabotage in occupied territory.

b. It can be constructed fast enough to keep up with rapidly advancing troops.

c. It can be used where vehicles cannot travel.

d. It is less susceptible to loss by fire.

35. Which of the following represents a disadvantage in using pipeline instead of vehicles for transporting a petroleum product?

a. It cannot be used to transport jet fuel.

b. It requires relatively flat and smooth terrain.

c. It cannot be used to transport more than one type of fuel.

d. It cannot be constructed fast enough to keep up with rapidly advancing troops.

36. To meet the wide-ranging petroleum requirements of World War II, military pipelines were constructed from

a. Spain to France; from Denmark to Germany and France.

b. Fedala to Casablanca in North Africa; from Denmark to Germany, and from Spain to Northern France.

c. England to France; from Naples, Italy into Austria.

d. England to France; from France to Germany, from India to China.

EXAMINATION CONTINUES

37. The United States operates military petroleum pipelines in which of the following?

a. West Germany, Philippines, and France.

b. Korea, West Germany, and Okinawa.

c. France, England, and Okinawa.

d. West Germany, Okinawa, and England.

38. What is the storage capacity of Pohang, base terminal of the US Army pipeline in Korea?

a. 314,000 barrels.

b. 414,000 barrels.

c. 514,000 barrels.

d. 614,000 barrels.

REQUIREMENT. Exercises 39 through 50 are true-false. Indicate the answer on the answer form by using A for true and B for false.

39. The 1,200-gallon tank truck has a delivery pump that is primed by the force of gravity.

40. The fuel system supply point should be located in an area where trees or other natural cover provides some means of concealment.

41. The tape and bob type of gage is used to determine the temperature of fuel in a storage tank.

42. Section 4 of a specification covers the quality assurance provisions, including tests and examination.

43. The primary concern in purchasing burner fuels is to make sure that different brands of fuel are compatible.

44. In oversea areas quality testing of petroleum products is performed by the military service having custody of the product.

45. Gasoline stored in tanks where the temperature does not average 90° F must be tested each 6 months.

46. A petroleum testing laboratory overseas that is scheduled for closing may be continued in service if it is required to support the department maintaining it.

47. Gum or oxidation inhibitors placed in fuel give permanent protection against gum formation.

48. The installation petroleum officer determines when and in what quantities off-specification aviation gasoline may be blended with regular automotive fuel to produce a premium grade.

49. Unloading facilities at dockside tanker unloading installations should be able to unload the largest tanker in less than 24 hours.

50. By special authority granted by France to NATO, US forces currently operate the Donges-Metz military pipeline.

END OF EXAMINATION

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